Designing Infrastructures for Learning: Technology and Human Praxis

a sociotechnical and sociocultural perspective to designing IT infrastructures in a resource constrained settings

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A SOCIOTECHNICAL AND SOCIOCULTURAL PERSPECTIVE TO DESIGNING IT INFRASTRUCTURES IN A RESOURCE CONSTRAINED SETTINGS

BY
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DENMARK

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CV

Geoffrey Tabo Olok received his master's degree in Computer Science from Makerere University, Kampala. He then served as research coordinator and assistant lecturer at Makerere University's Faculty of Computing and Information Technology. Currently, he is a lecturer at the Department of Computer Science, Gulu University where he served in many other capacities. As a lecturer, he has lectured and continues to lecture graduate and undergraduate programmes in ICT4D, System Analysis and Design, Software Engineering, software project management and general ICT courses. He has also made presentations at both local and international conferences.

His research interests are currently in higher education, infrastructures for learning, human development, learning, technology-enhanced learning, technology integration, information technology for development, eLearning and generally ICT4D. Further interest is in eHealth, mHealth, Health Informatics and information systems where a few publications in eHealth came through in peer reviewed journals.

ENGLISH SUMMARY

The study explored alternatives to integrating information and communication technology in higher education within a resource constrained setting in Uganda. Information and communication technologies are transforming higher education from the traditional approaches to spur new ways of teaching and learning. Higher education institutions in developing countries are particularly faced with many challenges that can be summarised generally as resource limitation. IT infrastructure for learning is yet another challenge that teachers, students and administrators are faced with in the wake of the need to integrate ICT in higher education.

In this thesis, I present steps toward designing infrastructure for expanding teaching and learning in higher education institutions from sociotechnical and sociocultural perspectives. Studies have shown how infrastructure becomes transparent, formed by use, and progressively evolving making it a process rather than a product. As such, infrastructures are sociocultural and sociotechnical constructs. This study focuses on the development of a digital infrastructure for learning in a resource constrained university setting. The aim is to support the advance of new pedagogical methods and practice for teaching and learning, to provide the basic principles for the design of infrastructure, and to explore methods for implementation and uptake of the infrastructures for learning by academics.

The use of participatory methods was adopted to address sociotechnical and sociocultural aspects of user participation in design and implementation of the digital learning infrastructure. Cultural Historical Activity theory (CHAT) offered the theoretical lens for the different interventions.

This study comprises four parts in all; i). theoretical reflections on the concept of infrastructure for learning, ii). related work and a survey of infrastructure design in selected universities in Uganda, iii). design workshops and reflection based on focus group discussions with key stakeholders of Gulu University, iv). Discussions and conclusions presenting some principles for design of infrastructures for learning.

Workshops described in this thesis resulted in shared objectives amongst staff about infrastructure and PBL pedagogy following historical tensions and contradictions. Adoption of blended learning is a result of working around those tensions tied with IT infrastructure and traditional teacher centred approach. The design and implementation of infrastructure that would support emerging pedagogies in higher education taking into consideration the sociotechnical and sociocultural perspectives is a slow change process. The results in this study can inform policies towards engaging users in designing, implementing and uptake of technological solutions in order to expand and transform teaching and learning, and could lead to improvement of the work environment.

DANSK RESUME

Afhandlingen udforsker alternative muligheder for integration af informations- og kommunikationsteknologi i videreuddannelse i Uganda, under forhold med manglende ressourcer. Informations- og kommunikationsteknologier transformerer videregående uddannelser i Uganda fra traditionelle tilgange til nye undervisnings- og læringstiltag. Institutioner i denne sektor i udviklingslande er i særdeleshed præget af mange udfordringer som generelt skyldes begrænsede ressourcer. Med det stigende behov for at integrere IKT i videreuddannelsessystemet, møder lærere, studerende og administratorer også en anden udfordring i form af utilstrækkelig IT-infrastruktur.

Fra et sociokulturelt og socioteknisk perspektiv, præsenterer afhandlingen metoder til design af infrastruktur til understøttelse af undervisning og læring på indenfor sektorn for videregående uddannelser. Studier har vist hvordan infrastruktur bliver synlig, formet via brug og konstant under udvikling, hvilket gør det til en proces frem for et produkt. Infrastrukturer er som sådan sociokulturelle og sociotekniske processer. Dette studie fokuserer på udviklingen af digital infrastruktur til understøttelse af læring i et ressource-begrænset universitets-setup. Formålet er at fremme nye pædagogiske metoder til og praksis for undervisning og læring; at tilbyde grundlæggende principper for design af infrastruktur; og at udforske metoder til implementering og ibrugtagning af infrastruktur til læring.

Afhandlingen bruger participatory design til at adressere sociotekniske og sociokulturelle aspekter af brugerdeltagelse i design og implementering af digital læringsinfrastruktur. Kulturhistorisk virksomhedsteori inddrages som teoretisk tilgang til de forskellige interventioner.

Afhandlingen består af fire dele: i) Teoretiske overvejelser i forhold til konceptet læringsinfrastruktur; ii) Relaterede studier og en undersøgelse af infrastrukturdesign i udvalgte universiteter i Uganda; iii) Designworkshops og refleksion baseret på fokusgruppediskussioner med nøglepersoner på Gulu University; iv) Diskussioner og konklusioner vedr. principperne for design af læringsinfrastruktur.

De workshops som beskrives i denne afhandling havde til formål at skabe fælles mål hos universitetspersonalet i forhold til infrastruktur og PBL efter en historie præget af spændinger og modsigelser. Hensynet til spændingsforholdet mellem voksende IT-infrastruktur og den traditionelle lærercentrerede tilgang har resulteret i valg af Blended Learning som undervisningsform. Design og implementering af infrastruktur til understøttelse af nye læringstilgange i videreuddannelse under hensyntagen til sociotekniske og sociokulturelle perspektiver er en langsigtig forandringsproces. Resultaterne i denne afhandling kan bruges til at forberede procedurer til at engagere brugere i design, implementering og anvendelse af tekniske løsninger til udvikling og

ændring af undervisnings- og læringstilgange som igen vil kunne føre til forbedring af arbejdsmiljøet.

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CHAPTER 1. INTRODUCTION

> *"People who study how technology affects organisational transformation increasingly recognise its dual, paradoxical nature. It is both engine and barrier for change; both customisable and rigid; both inside and outside organisational practices. It is a product and a process" (Star and Ruhleder, 1996).*

In this text, Star and Rhuleder explicate the complexity of studying infrastructure that presents itself in many forms. Looking at infrastructure as a product and an ongoing process is befitting to this research. This chapter presents the overview of the research with problem formulation and relevance to scientific community.

1.1. GENERAL INTRODUCTION

Higher education in the East African region is regarded a symbol for regional and national development (Oketch, 2009). Most communities have confidence in university education as the future for the children and future generations making it a collective pride. The demand for access increases almost exponentially with community appreciation that higher education is key for modernisation (Teferra & Altbachl, 2004). Modernisation and development are achieved through human resources development. Human resource capital is widely recognised as essential for economic development (Deininger, 2003) of a nation. As noted by Oketch (2009), this has been the case since independence in many countries in Sub-Saharan Africa. In Uganda, the percentage of graduates with degrees and higher degrees increases yearly, causing an increase in the overall unemployment rate of 10% and that of the youth at nearly 20% with the urban having a higher rate compared to the rural areas (UBOS, 2015). This increase matches the rise in the demand for higher education and the increase in the number of universities both public and private to match the provisions of internationalisation of higher education beyond the region (Ogachi, 2009). Public university here refers to government or state-owned university and are run by the state.

In the current Ugandan education system, focus is placed on individual student's performance based on their capability to memorise and compete. This system sees competition valued higher compared to cooperation (Laal & Ghodsi, 2012) amongst learners who are expected to exhibit attributes of cooperation in their employment. Collaborative learning offers higher achievements and greater productivity (Laal & Ghodsi, 2012). Gulu University is in the process of introducing new pedagogical models that are aligned to collaborative learning approaches supported by Information and Communications Technologies (ICTs).

1.1.1. GULU UNIVERSITY

This research is carried out at Gulu University in Uganda. This university is one of the seven public universities in Uganda. Gulu University was established in 2002 by an Act of parliament of the Republic of Uganda, Universities and Tertiary Institutions Act 7 of 2001(Ugandan Parliament, 2001). The university was established in the region at the height of the armed conflict that had lasted for nearly two decades. It was therefore established with the aim of increasing access to higher education and also bringing higher education closer to the people who had suffered from the insurgency for so long. The institution is therefore one of the iconic initiatives for development in the region with ability to teach as well as carry out research and outreach for transforming communities. The University moto is to provide access to higher education, research and conduct quality professional training for the delivery of appropriate services directed toward community transformation and conservation of biodiversity. To achieve this mission, the university has developed programmes in health, agriculture, science, education, business and development, law, peace and strategic studies over the years. With the bar set so high, the university is in the process of transforming its business process to provide education services with 21st century skills. These skills are delivered through educational technologies and more specifically, information and communication technology.

ICT supported learning has become an integrated part of University education (Nyvang & Bygholm, 2012) and all other tertiary education institutions. We see pedagogy oriented international standards being introduced to focus ICT based techniques for managing content (Mwanza & Engeström, 2005). The entire professional environment in the university is supported by ICT and in learning, problem based learning, computer supported collaborative learning (CSCL) and networked learning (NL) as examples of variety in learning design that apply ICT in support for learning (Jones, 2009; Kolmos, 2009; Nyvang & Bygholm, 2012) However, Nyvang and Bygholm stress that ICT utilisation by institutions, departments and staff depend on the kind of ICT and assumptions about which designs for learning are most productive. ICT Infrastructure is, therefore, an important part of the infrastructure for learning framework defined by the design and implementation strategy.

In relation to teaching and learning, Guribye and Lindstrom (2009 p.105) suggested that:

> . . . infrastructure for learning should refer to the interconnectedness of artefacts and of how such artefacts are themselves intermeshed with other technological, institutional and social arrangements.

Understanding the technology adoption process requires an in-depth appreciation of the technical features, social context and culture of the workplace in which it is

introduced. This area is often ignored by the University Administration with the assumption that they are handled as technical specification by expert designers. The technicians (developers and system administrators), therefore, resort to using technical difficulties to mask higher order conceptual problems centred around that work practice and standards, leading to failure of users to recognise the complexity of their domains, hidden assumptions and various motivations of all stakeholders (Star & Ruhleder, 1994). To a have network that is supported by certain technological, organisational and communicative structures with a focus on the transformation of these structures in relation to the practice (Nyvang & Bygholm, 2012), user participation in the design and development is vital. It is dangerous to expect designers to learn formal and informal aspects of user domains. The option is to involve users at the initial stages of the design so as to remove the assumption by designers that all requirements can be formally captured and coded and from the users that technical systems can solve all social and organisational problems (Star & Ruhleder, 1994).

1.2. INTRODUCTION TO THE STUDY AND THE STUDY CONTEXT

The importance of quality, innovation and creativity in higher education in an African context in the 21st century cannot be over emphasised (Atibuni et al., 2017). Innovation and creativity are key traits of a well-trained graduate that is employable in today's dynamic industry. Much gains have been made in expanding access to formal and higher education. However, achieving good quality remains subtle (Asankha & Yamano, 2011; Birungi et al., 2016). Today there is an increasing gap between the number of candidates graduating from the universities and the employment of the youth holding a university degree (UBOS, 2017). Higher education in developing countries, therefore, continues in a quest for better quality and skills in line with the societal needs. These are often formulated as a need for 21st century skills: problem formulation, problem-solving, innovation and collaboration. This introduces problem based instructional innovations where problems form the core of learning (Kiguli-Malwadde et al., 2006) and are positioned to specific contexts while drawing on theories and global knowledge to solve those problems, in which process learners and facilitators acquire unique skills in engaging in critical reasoning with tools for problem-solving (Bell, 2010). In such environments students are encouraged to explore what they know to understand the problem better (Kiguli-Malwadde et al., 2006; Kolmos, 2009). Problem-Based Learning (PBL) sets goals for students to plan, discuss ideas, communicate ideas, gather information, implement and evaluate mini projects with real-world applications (Anicic & Mekovec, 2016). This innovative pedagogical approach is coupled with technology-enhanced learning. Today, in a networked world with internet and advanced information technologies, there are endless applications for supporting education in developing countries. In the context of Uganda this is being addressed in two national plans, that of Uganda vision 2040 (Uganda National Planning Authority, 2012), Uganda National Development plan 2010/11-2014/15 (Uganda National Planning Authority, 2010) and Education

and Sports Sector strategic plan 2017/18-2019/20 (Uganda Ministry of Education and Sports, 2017).

With computers and internet technology advancing at fast rate, several models of learning are made possible. This research project envisions to integrate both a search for more tangible methods of university teaching and learning in line with the 21st century skills and digital learning to make possible these new ways of learning in the context of a resource constrained country as Uganda. More precisely, Gulu University is looking into adopting the principles of problem and project-based learning in the master's courses as enshrined in the project application for building stronger universities. Blended learning a mix of traditional teacher centred, the PBL with electronic learning (eLearning) or digital learning are envisaged to increase access and improve quality of teaching and learning in the university where resources are limited.

ICTs have been related to universities and research institutions from the beginning (Ramadhan & Arman, 2014) and its development has enabled implementation of new services which inspire changes in teaching, learning and research. The use of digital method provide flexibility of time and place, simple organisation and management of tasks, (Henderson, Selwyn, & Aston, 2015) and enable learners to revisit all forms of learning materials as and when they require. With the flexibility offered to the learner and educator, technology mediated learning may also avail more time for research and outreach as well as reduce pressure on the physical infrastructure. However, studies on affordances (Kaptelinin & Nardi, 2012; Kukulska-Hulme & Jones, 2012), co-design (Sanders & Stappers, 2008), user participation (Sanders, 2002), participatory design (Spinuzzi, 2005) and designing for change (Coto, 2010) are increasingly becoming popular.

ICT in higher education is adopted as tool to stimulate achievement of institutional goals such as of flexible provision and sustainable growth (Henderson et al., 2015) and as an enabler of pedagogical innovations. Studies into the concept of design of technology-enhanced learning and Networked Learning (NL) in higher education requires a focus on infrastructure as relationship between technology, educational practices, organisation and knowledge involved in shaping educational practice with technology (Nyvang & Bygholm, 2010). The relationship is defined by the ICT infrastructure that is purposively designed to serve, control and manage teaching and learning as education work practice. In relation to this research NL is a concept in which ICT is used to promote connection between learners themselves, with educators, and learning community and its learning resources (Jones, 2012). The learning resources are defined in the learning management system as objects central in promoting these connections. The system could include eLibrary, content management sub system, eLearning sub system, and other supporting applications and technologies.

The use of information and communication technology for learning is not yet mainstreamed in universities in Uganda. However, it has a high priority in the government plans and strategies for the development of higher education (Uganda Ministry of Education and Sports, 2017). These priorities are to ensure efficiency and effectiveness in education through increased funding, improving quality assurance in universities and higher institutions of learning; restructuring programmes to make them relevant to the national development goals; strengthening the Education Management Information System (EMIS) to improve collection and processing of accurate and timely information for decision-making (Uganda Ministry of Education and Sports, 2017). To achieve the EMIS, the government is working toward improving ICT infrastructure and reducing cost of bandwidth to the consortium of universities in Uganda. Furthermore, developing agencies are making this vision possible by supporting digitalisation both as a means to making university education accessible to more students and developing new educational programs and pedagogical principles integrating the possibilities of digitalisation. This project is going to research into this unique situation, where there is a momentum to research into the implementation and use of new pedagogical approaches supported by ICT.

Studies of information system have traditionally modelled computers and humans as information processing devices using the computer metaphor (Guribye, 2005), making it difficult to delineate their roles. Thus computer automation has occupied the more privileged positions at the workplace because of lack of social analysis by the scientists (Guribye, 2005). Re-examining the need to account for social perspectives within infrastructure broadens our understanding of infrastructures as a relation (Star & Ruhleder, 1996). This conceptualisation of infrastructure is a good starting point to researching into a more specific notion of infrastructure for learning.

1.3. PROBLEM AREA

Many studies relating to infrastructures have noted it's dual nature in relation to communication and culture (Goodyear, 2005; Guribye, 2015; Star & Ruhleder, 1994, 1996). Specifically, the interconnectedness between IT and its applications and telecommunications into networked systems has been referred by Guribye (2005) as information infrastructure. In this type of infrastructure, the internet is the enabling technology and it plays the most crucial role. The interconnectedness is a characteristic of contemporary society that has resulted in the use of the term networked society (Guribye, 2005). This term has underlying conceptualisation in the social and cultural perspectives of society that relates to learning.

E-learning in developing countries like Uganda is still marginal in the life of most academics, with many institutional eLearning platforms used as content repositories – or content management system. Such systems are being used to organise and manage academic project activities but more less summer schools, workshops, seminars and

conferences. Notably, there is little documentation of institutional readiness (e.g. in content quality, teacher' confidence, supporting policies and enabling infrastructure) to adopt, implement and mainstream eLearning (or generally technology-enhanced learning) in higher education institutions.

There are various Learning Management Systems (LMS) already designed to support content delivery in higher education that are available either as open source or proprietary. In the case of African countries, little is known on the extent to which such LMS provides for Problem Based Learning. However, a study from a medical school in Ghana suggests that there are uncertainties how PBL can succeed in resource constrained settings based on the inadequacy of literature on implementation (Amoako-sakyi & Amonoo-kuofi, 2015). Resource constrained settings here refers to the lack of human resources (lecturers to implement the programmes, skilled technical personnel), ICT infrastructure for learning, and finance for such new ways of learning in the context of Uganda.

As Gulu University introduces both e-learning and PBL simultaneously, it is interesting to understand how these will impact on infrastructures for learning. Research into organisational issues relating to viable designs and adoption strategies in designing and implementing of infrastructures in higher education are essential (Jones, 2009; Nyvang & Bygholm, 2010). Contextualising research within Gulu University presents a paradox that is researchable from an inclusive approach through design. The general context and meaning of designing ICT systems is being resolved through the emergence of multidisciplinary development teams where users and designers, systems analysts and other professions work together throughout the project (Star & Ruhleder, 1994). This multidisciplinarity presents a learning platform to stakeholders to understand concepts of designing and implementing infrastructure for learning.

Infrastructure are theoretically layered. The layers describe unique purposes and meanings that are related to the core of decision-making in design. The layers are defined as *micro*: the more technical aspects like technology development, devices and artefacts. The *meso*: involves how people interact with the system and how to deal with user experiences. This level describes sociocultural and sociotechnical perspectives. Finally, *macro:* deals with the theoretical aspects such as pedagogy, learning design, content design and learning theories.

It is important to critically examine all levels during the design phase of a project with consensus from stakeholders. This consensus could be achieved based on the capacity of the infrastructure installed base (Star & Ruhleder, 1996) that accommodate future designs.

This study relates to the meso-level involving design of a framework (Nyvang & Bygholm, 2010) presupposing that meso-level helps in understanding the basic conditions for collaborative learning and collaboratively driven change at the institution. Infrastructure in the organisation is both sociotechnical and sociocultural. Since infrastructure is sociotechnical (Jones, 2009), they rely on an integration of various kinds of artefacts with organisational features and processes. It is, therefore, important for universities to develop systems to improve reliability and user friendliness with possibilities to extend availability and accessibility to core systems (Henderson et al., 2015). This study explores infrastructure from a sociotechnical and sociocultural perspective to comprise technology and human praxis.

1.4. PROBLEM FORMULATION AND RESEARCH QUESTIONS

Infrastructure and the concept of infrastructure are not new to academia as well as industry. Practitioners and researchers working with IT infrastructures and ICT applications at one point might have felt that infrastructures are problematic and complex. The infrastructure problems are easily recognised when a break down occurs (Star & Ruhleder, 1996). This makes infrastructure transparent or a black box that are acknowledged in crisis situations. The breakdowns occur frequently in developing countries specifically in higher education institutions. However, despite these deficiencies, institutions continue to deliver on their mandate. Defining infrastructure in abroad sense to include organisational (education) systems, presents many design and sustainability challenges of infrastructure. Specifically, for Uganda, prominent challenges are presented with the technologies, supporting infrastructures (electricity) and resources that are consumed by ICT Infrastructure. Networked capacity in most institutions is not widespread with a low score in networked readiness (Ayoo & Lubega, 2008).
This research project is an attempt to address infrastructure for learning – both at the conceptual level and at a practical level. The research takes point of departure in a case study of Gulu University – Uganda.

The university presents an interesting case because within Gulu University there is focus on promoting new ways of teaching and learning in line with the 21st century skills, especially problem and project-based learning and technology-enhanced learning thus developing Gulu university e-campus. These engagements are backed by donor contributions to capacity building and general development of the university. Grants from the Danish Ministry of Foreign Affairs Building Stronger Universities in Africa (BSU) through supporting research capacity development in 6 African Universities including Gulu University and the African Development Bank. Because of the university's commitment to change and transformation, it presents a very interesting case for rolling out new approaches to learning while integrating ICT, referred to generally as technology-enhanced learning. This PhD research is

specifically concerned with the issues of designing infrastructures for learning in resource constrained setting taking a case of Gulu University in Uganda.

The concept of infrastructure for learning is generally an approach to understanding the social and technical conditions of learning practices (Guribye, 2005). This is comparable to manufacturing companies using new approaches that define products people need (Sanders & Stappers, 2008). Otherwise the practice of defining products based on user needs is grounded in education where design is approached from an expert teacher perspective giving user opinions less value (Ibid). The notion of infrastructures for learning makes sense in relation to practices and organisational working arrangements (Guribye, 2005). In learning, specific pedagogical model links new tools and IT environment particularly where technology is introduced without theoretical understanding how it affords pedagogical model (Guribye, 2005). Particularly learning management systems are designed in accordance with training or learning scheme termed by Wenger as extractive training scheme, where LMS are deployed according to the pedagogical requirements (Guribye, 2005). Infrastructure for learning in this research will be defined by the learning tools based on a new pedagogical model, organisational arrangements and computing facilities (Hardware, Software, applications, Policies) in the university.

In this project I understand and take designing infrastructures for new ways of learning as a crucial issue since pedagogy and practice unfold in a dialectical response to the infrastructure. The infrastructure does not determine the pedagogy and practice; however, it should afford the practice of teaching and learning. It is important to emphasise that infrastructure for learning emerges in relation to practice (Guribye, 2005). In our case, teaching and learning is taken as a practice involving several stakeholders and or actors. Furthermore, infrastructure investments are expensive so it should be sustainable and emphasise the right design decisions. Therefore, to focus on the digital infrastructure in resource constrained settings in support of the development of new pedagogical methods for learning are crucial, as well as design issues and methods for implementation. It is important to take into account the infrastructures for learning by staff, students, partners and civil society organisations.

Based on this the following overall research questions have been formulated:
How can sustainable infrastructures be conceptualised for learning in a resource constrained setting, which take into account a sociotechnical and sociocultural perspectives?

i. To what extent do existing requirements for institutional infrastructure for learning align with new pedagogical models involving problem formulation, collaboration and interdisciplinary ways of working?
ii. How can infrastructures for learning be designed to accommodate the sociotechnical and sociocultural perspectives of new ways of learning?
iii. To what extent has the infrastructure design incorporated the sociotechnical and sociocultural perspectives for change?

iv. To what extent does the infrastructure afford the new ways of teaching and learning?

1.5. RESEARCH RELEVANCE

Following from the research objectives, the work will in part extend the field of participatory design methodology by applying its principles and opening debates on how to design for learning in a resource constrained setting in developing countries.

Similarly, this work also contributes to discussions in the field of PBL/NL/and blended learning by presenting research directions, current literature, application and implementation in developing countries.

Focusing on infrastructure for learning, this study explicates the dialectical view of the infrastructure from the sociocultural and sociotechnical perspectives. Therefore, contributing to the theories of change and conceptual and theoretical understanding of infrastructure and its scope.

1.6. RESEARCH CONTRIBUTIONS

This research is an attempt to present infrastructure for learning from a more holistic view by integrating Sociotechnical (Guribye, 2005; Star & Ruhleder, 1996) and Sociocultural (Guribye, 2015) perspectives.

The research follows a participatory design intended to bring about change in institutions, ICT setup, organization, management and the use of infrastructure for learning in resource constrained settings. These narrative and experiences presented could apply to similar settings.

Discussing Participatory Design as an alternative methodology of introducing technology-enhanced learning in higher education in the Gulu University context presents a new approach. Similarly, the explorative and systematic introduction of new innovative pedagogy, infrastructure design within this research context is new in the Ugandan context.

From a methodological stance, the participation of the stakeholders in technical and non-technical issues presents a unique perspective in attempting to provide a pathway to user experience, Co-Design of teaching and learning with Information Technology with integration of practice based approach. The methods used here are new to the environment thus breaking new grounds for current and future researchers.

Using Activity Theory (AT) theoretical framework and grounding the study contribution through Expansive Learning in resource constrained environments contribute to strengthening user participation in the design process.

1.7. POSITIONING RESEARCH CONTRIBUTIONS WITHIN THE SCIENTIFIC COMMUNITY

This is an interdisciplinary study accounting for many forms of learning (NL, Technology-enhanced learning, computer supported collaborative leaning, blended learning and eLearning, amongst others). However, it contributes more to technology-enhanced learning and blended learning paradigms. It advances discussions into how participatory design could be an effective methodology to address sociocultural and sociotechnical perspectives in designing infrastructures for learning.

Technology-enhanced learning and blended learning communities design systems that are aligned to an expert knowledge with little participation of users. Some sources report that design practice has been related to technical objectives with little concern given to organisational (Mumford, 1983) and user contexts but this study attempts to address both. Current trends in design of technology is moving to social aspects of technology with human centred design perspective (Maia, Teicher, & Meyboom, 2015). Sustainable technology-enhanced learning systems need to have a strong bearing to the practice and or user perspective related to the organisational context of learning.

CHAPTER 2. RESEARCH CONTEXT AND RESEARCH SETTINGS

2.1. INTRODUCTION

Uganda is a resource constrained country just like many developing countries in Africa. However, the country is undergoing many infrastructural improvements especially in IT infrastructure development. In this Chapter, I start by elaborating the broader IT infrastructure, emphasising electricity as the key supporting infrastructure in Uganda.

2.1. TECHNOLOGY-ENHANCED LEARNING IN UGANDA

Higher education in developing countries is an investment in change and human capital development continuously demanded by the population (Bunoti, 2011; Kahiigi, Ekenberg, Hansson, & Tusubira, 2004), and it creates a dynamically competitive environment in the region. With privatisation, Uganda has seen a tremendous increase in the number of privately-owned universities and tertiary institutions attempting to satisfy this demand. The increasing student population, amidst the limited resources in public institutions, makes delivery of quality education difficult (Omoda-Onyait & Lubega, 2011), let alone the use of traditional learning methods where learning takes place in a specific place and at a specific time (Ayoo & Lubega, 2008). Additionally, the liberalisation of higher education has led to Uganda experiencing an influx of students from neighbouring countries in East Africa. This has further resulted in the increase of student- teacher ratio (Ayoo & Lubega, 2008). The institutions' absorption capacity increased despite the fundamental question of low quality of graduates from the institutions compared with the twentieth century Ugandan education system, particularly in terms of higher education (Bunoti, 2011). Quality education is primary as stated in the United Nations Sustainable Development Goals (SDGs), and the process to ensure quality delivery is a dominant purpose of these institutions (Bunoti, 2011).

Technology advances have contributed heavily to the paradigm shift in education (Ayoo & Lubega, 2008), enabling ubiquitous learning. The advent of technology has made many delivery methods toward student-centred learning possible. eLearning is one such alternative method adopted to reach students in remote places, making education for all achievable. As much as this is true for developed countries which enjoy the benefits of technology, it is not the case in African public universities

(Omoda-Onyait & Lubega, 2011). In developing countries, especially in Africa, most of these practices related to technology-enhanced learning are still in their infancy. Many education institutions in Uganda are adopting a new form of blended learning—which is a combination of technology-supported and traditional learning methods. Technology-enhanced learning is expected to have a huge potential in delivering education with innovative ways of learning (Ayoo & Lubega, 2008).

One study showed a decade long research on technology-enhanced learning with most of the research concentrated on adoption, policy, regulations and socio-economic issues in adoption with less emphasis on the technology and technological barriers to eLearning (Ssekakubo, Suleman, & Marsden, 2011). Such studies however lack understanding of infrastructure and infrastructure design for learning in both a general and developing country context. Thus, the identification of suitable strategies for effective e-Learning implementation (example in Kahiigi et al., 2004) is important. Understanding infrastructures in relation to all forms of technology-enhanced learning delivers long-term goals with sustainability.

2.2. IT INFRASTRUCTURE IN UGANDA

Uganda is a landlocked country, which has been categorised as a developing country, like all other East African countries. Moreover, it receives all of its imported goods and services through either Mombasa (Kenya) or Dar-es-Salaam's (Tanzania) ports, respectively. Uganda's geographical location presents several challenges to the development of infrastructure in general. The country has a very small resource envelope, so many of its development projects are either donor funded or funded through loans from international financial institutions. This negatively impacts education in the country as research facilities and infrastructures for learning are not developed in accordance with the required international standards.

Over the last 10 years, the East African region has devoted resources to ICT to enhance education, research, training, collaboration and business. The installation of the submarine cable system in the Indian Ocean enabled connectivity within the region and internationally, thus significantly lowering the costs. Governments have constructed the infrastructural national fibre backbone to major cities and towns. For example, the government of Uganda used a three phased approach (National Information Technology Authority Uganda [NITA-U], 2015) to connect all major towns to the fibre backbone. According to the same report, by 2015, all connected major towns, ministries and departments were receiving high-speed internet through the National Backbone Infrastructure (NBI) sometimes referred to as e-Government Infrastructure (EGI). The regional towns are also used as test centres for eGovernment services that have steadily covered all major towns or local government headquarters (NITA-U, 2015). Education institutions are treated here as departments within the Ministry of Education although the universities are semi-autonomous according to the law of the land.

Universities and other higher education institutions have made the last mile of connections to their campuses to benefit education services, improving the infrastructure and access to electronic resources. This is contributing to research collaborations and the sharing of research resources amongst both local and international partner institutions. The ICT infrastructure has also led to better research outcomes because scholars are able to access current research materials and publish research results in international peer reviewed journals. These publications are made readily available and accessible through partnerships and research networks.

Higher education institutions (mainly universities) and research institutions in Uganda are under their umbrella organisation, the Research Network Uganda (RENU), which was formed in a bid to make bandwidth for teaching and research more affordable, thereby allowing these institutions to share libraries and research materials and to collectively benefit from international collaborations. This initiative by universities has managed to further reduce the cost of bandwidth, improve availability and reliability and increase access to information resources on the internet within universities. Although this is true, the demand for better ICT services is increasing in universities at a very high rate. The need to develop conducive institutional high-quality learning environments through ICT remains on the agenda for infrastructure for learning. The introduction of blended learning in most universities has created a quest for increased bandwidth and high-speed internet connectivity. The availability of personnel and expertise to manage these infrastructures could pose another dilemma for institutions, thus increasing the pressure on the already resource constrained institutions. This is a challenge because the salaries for the support staff are often low, and well-trained professionals seek better employment elsewhere.

2.2.1. ELECTRICITY SUPPLY AS SUPPORTING INFRASTRUCTURE

Uganda has registered a commendable level of growth in the energy sector over the last decade in the wake of industrialisation. There are more than eight hydroelectricity generating power dams currently running in the country, producing several megawatts of electricity for internal use and for export to countries such as Kenya and Rwanda. The electricity distribution network in Uganda covers most parts of the country. The rural electrification programme has played a major role in achieving the goal of supplying energy for domestic consumption. Main consumers of electricity in the countryside are ICT installations, such as relay masks from telecommunication companies and household ICT services. As positive as this seems, there are many complaints arising about frequent outages. The services need to be reliably accessible to higher education institutions so that information technology (IT) can be used to deliver learning (Basaza, Milman, & Wright, 2010). However, these institutions suffer losses of equipment and service delivery time based on the unreliability of the supply. The cost is also very high compared with the international standards per unit

consumed. The cost is approximated at about UGX 385.6 per kWh, although the cost reflected in the tariff is UGX 828 per kWh showing that government subsidises for the people (Mawejje, Munyambonera, & Bategeka, 2013). Because Uganda is a resource constrained country, this cost is higher than what the many citizen can afford. However, the more important part of this service is the availability and reliability of the supply to sustain ICT systems.

Gulu, being an upcountry town, faces severe power outages which force institutions to run alternative power sources, making IT an expensive undertaking. Generators are a common source of electricity in the town and in the university, although there have been attempts to install direct current batteries in server rooms. Also, solar energy is a promising technology; however, the initial installation cost is quite heavy for institutions, and that does not consider the necessary knowledge and skills of technical personnel to maintain these technologies in an environmentally challenging area. For example, the increased reliance on thermal energy with its high cost required the government to increase subventions to save citizens from price increases (Mawejje et al., 2013).

While this peripheral infrastructure (electricity) is a challenge to sustaining the infrastructure for learning, there is a political will to develop integrated power sources (solar and hydro) to remedy the situation because provision of the service is affected by electoral considerations (Trotter, 2016). These developments are now underway by the government, which will increase supply and reduce costs in a few years when these new power generation stations are operational and service becomes more available and reliable.

Electricity, in this case, is taken as a peripheral infrastructure since it does not directly affect the design of infrastructure for learning other than its operation and function. In this thesis, therefore, I do not dwell on discussing the details of its development, but it needed to be illuminated to present the concern of the resource constrained environment.

2.3. RESEARCH CONTEXT

Higher education in developing countries is considered as the organisation responsible and accountable for investment in human capital development. It is continuously in high demand from the population and thus has created a dynamically competitive environment (Bunoti, 2011; Kahiigi, Ekenberg, Hansson, & Tusubira, 2004) within the East African region. From colonial times, Uganda has provided an environment for academic excellence in the region. With privatisation, a country such as Uganda has seen a tremendous increase in the number of privately-owned universities and tertiary institutions springing up to satisfy this demand. The increasing number of students with currently limited resources in public institutions make delivery of education difficult (Omoda-Onyait & Lubega, 2011), let alone the use of traditional

learning methods where learning takes place in a specific place and at a specific time (Ayoo & Lubega, 2008). Additionally, with the liberalisation of higher education, Uganda has experienced an influx of students from neighbouring countries within the East African region and Horn of Africa (Ethiopia, Djibouti and Somalia). As a result, we see a further increase in the student-teacher (lecturer) ratio (Ayoo & Lubega, 2008). It is also true that the absorption capacity has increased from the opening of so many new public and private universities. This has contributed to internationalisation of Ugandan higher education, making it accessible regionally with some level quality assurance (Ogachi, 2009). Another fundamental issue is the question of the current quality of graduates from these institutions (Bunoti, 2011). In the twentieth century, the Ugandan education system and higher education was well known for its excellence in training and research. The issue of quality in education is of prime importance, although the process to ensure quality delivered through a well-founded system should be the dominant focus of these institutions (Bunoti, 2011).

The education system is organised in a manner that university programmes are approved by the national council for higher education, which is an autonomous body under the umbrella of the Ministry of Education. In order to deliver on the promise of quality, universities and higher education institutions have the autonomy and mandate to explore various learning theories and methods that address some of the twenty-first century skills. This has made universities more creative in deciding on the pedagogical approach they feel is most relevant to the courses they offer. For example, we see competency-based education (CBE) in medical schools (Kiguli-Malwadde et al., 2006).

There are many education theories that inform researchers and managers of higher education on alternative decisions based on the need of the profession and job demands. Learning theories, such as constructivism, cognitivism and behaviourism, are some the lenses used to inspect the learning process and the learner's experiences (Kahiigi et al., 2004; Mackenzie & Knipe, 2006). The choice of a theory determines the learning methods, which subsequently determine the learning outcome and type of knowledge acquired. There are, however, many learning methods that are well described in the literature in relation to these theories (Kahiigi et al., 2004), for example, mobile learning, personalised learning, traditional learning, e-Learning, NL and blended learning, to name a few.

Technology advances have contributed greatly to the paradigm shift in education (Ayoo & Lubega, 2008) and have enabled ubiquitous learning. Also, with technology, many of the learning methods can now be available to a diversity of learners. However, although this may be true for developed countries which enjoy the benefits of technology, this is not yet the case in African public universities (Omoda-Onyait & Lubega, 2011). In developing countries, especially in Africa, most of these practices related to technology-enhanced learning are still in their infancy. According to Ayoo

and Lubega (2008), many education institutions in Uganda have acquired a new form of blended learning which is a combination of technology-supported and traditional learning methods. Technology-enhanced learning is seen to have a huge potential in delivering education with innovative ways of learning (Ayoo & Lubega, 2008).

Studies show that research has been going on for at least a decade on these technology-enhanced learning methods; however; most of the research has concentrated on adoption, policy, regulations, socio-economic issues in adoption, while less emphasis has been given to the technology and technological barriers to eLearning (Ssekakubo et al., 2011). In addition, many of these studies are not interdisciplinary, so they do not integrate knowledge, competencies and skills from other disciplines. Of late, we have seen many studies that report success as multidisciplinary and multinational studies, thereby addressing sociocultural issues in action research. However, these studies also seem to lack the understanding of infrastructure and infrastructure design for learning in respect to both a general and developing country context. Indeed, it is assumed that research results are consumed and applicable in a similar way independent of the resource availability and access to the managers of academic institutions. Identification of suitable strategies for effective e-Learning implementation (for example, see Kahiigi et al., 2004) or for PBL, blended learning or competency-based education implementation is important, and so it is worth understanding the infrastructures related to all forms of technology-enhanced learning.

2.3.1. DESIGN FOR LEARNING

The project/PBL pedagogy has a distinct synergy with twenty-first century skills. It promotes the use of technology as a tool for sharing change and transformation within the society where it is engaged in practice. A well-designed infrastructure for learning will promote collaboration, knowledge sharing and enhancing skills, especially in the higher education sector in developing countries.

In order to succeed in achieving the goals of new ways of teaching and learning, there is a need to systematically organise human resources, carefully invest and maintain ICT infrastructures for learning, and all these are taken as being as important as designing the learning itself. Often, these investments are not well maintained, despite heavy investment by the government and other development partners. For example, Ssekakubo et al. (2011) has argued that while the majority of universities in developed countries enjoy the benefits of e-Learning, most initiatives in developing countries have not been successful. The low level of success may be attributed to the top-down, expert- and technocrat-led design and implementation of such initiatives. Also, any of these initiatives have been supported by donor projects that target specific domains. Since they are primarily research and short-term ICT infrastructure development grants, they end up leading to sustainability challenges. E-learning initiatives in

developing countries have always partially or totally failed, with few success stories (Ssekakubo et al., 2011). This is evident by the number of universities running e-Learning programmes and notably few research publications, although the number is progressively on the rise. A user-centred participatory design approach, as described in this thesis, could help increase levels of user involvement in the entire process of system development, making the outcome more acceptable and sustainable.

2.3.2. INFRASTRUCTURE IN HIGHER EDUCATION

There is generally a lack of descriptive literature on infrastructure from sociotechnical and sociocultural perspectives in Uganda. A few published studies explicate how the infrastructure for learning is used. They describe the establishment and use of e-Learning systems (Ayoo & Lubega, 2008; Ssekakubo et al., 2011).

Uganda is seeing a wave of change in organisations and individuals taking transnational higher education which is delivered through online programmes or courses offered at university centres (Bunoti, 2011). These are made possible because of the stable national fibre optic backbone and the continuous upgrade of institutional infrastructure for learning. Figure 2-1 presents a summary of work by NITA-U in three phases: phase I in yellow, II in blue and III in green.

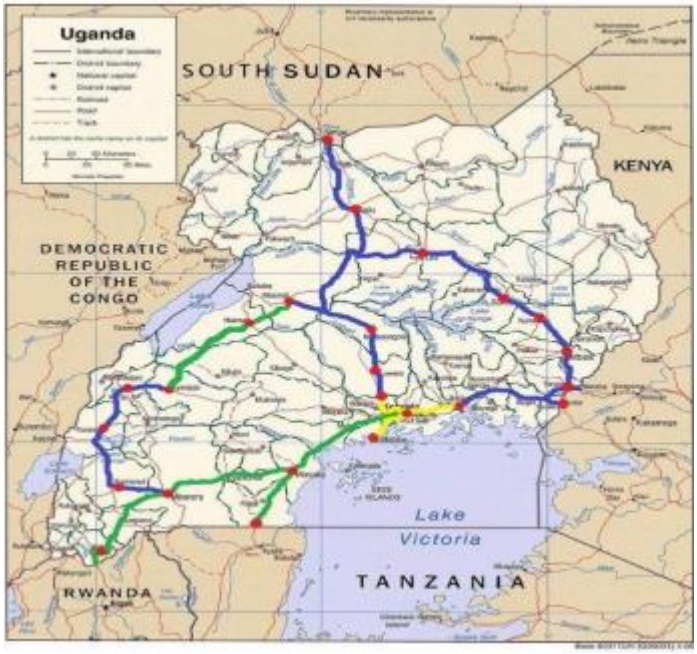

Figure 2-1: Fibre optic national backbone infrastructure (NBI). Source: NITA-U.

This development has improved connectivity and internet speed to all major towns in Uganda (NITA-U, 2015). Universities have begun to harness their processes to some of the ICT applications for management and learning. Staff, on the one hand, are changing their attitudes, leading to better staff professional development and preparation for delivering eLearning services. This trend has resulted in public and private universities operating satellite campuses with various models of blended learning across the country (Ayoo & Lubega, 2008). University colleges are meant to provide higher education services closer to the people, and this is made easier through blended learning and programming. There are distance education programmes, weekend programmes, evening programmes and day programmes catering to all groups of learners, independent of the spatiotemporal and geographical location.

In Makerere, Kyambogo, Mbarara and Muni Universities, we see traditional teaching methods and e-Learning attempting to blended in some colleges and CBE and e-Learning in others. Gulu University is in a similar situation, but it has introduced project and problem-based learning in some of the programmes as I indicated earlier, will make it a strongly blended learning environment in the near future. Makerere University alone has had three eLearning supported initiatives in the last decade, but with all yielding minimal success (Ssekakubo et al., 2011). According to Ssekakubo, the university continuously switched from Blackboard to Kiwl because of the high licence fees that were not sustainable with the hope that open source Kiwl would address the sustainability question. In a span of about two years, the university adopted Moodle, which is currently being used. The same Moodle platform was adopted and is being used in all these universities as their leaning management system. There are also other systems that have been developed and adopted by public universities for managing academics, for example, Academic Information Management Systems (AIMS) and finances Computerised Education Management and Accounting System (CEMAS) for campus management from the NITA-U and the Ministry of Finance, Planning and Economic Development (MoFPED) (NITA-U, 2015). These systems, which rely on ICT infrastructure, began to flourish when the national infrastructure fibre optic backbone was completed in sections of the country, thus making ICT services more efficient and reliable.

The government has made stable progress in improving the ICT infrastructure at the national level and in the universities; however, the design for learning is an issue for each institution and its stakeholders. Educational pedagogy is a central player in the decision of infrastructure design since it provides the theoretical and practical foundation for implementation and learning. Doing last mile connections and fixes to design internal systems that answer the needs of the pedagogy could require a participatory design approach given the knowledge environment in universities.

2.3.3. STEPS TOWARD TECHNOLOGY-ENHANCED LEARNING

The use of technology in education in Uganda is generally encouraged by the government (Ayoo & Lubega, 2008) through advocating for it, which has resulted in many institutions adopting it to enhance traditional teaching at their respective levels. Decision on strategies to design and actualise the use of ICT in education is a question of which levels of education are addressed. In universities, the actual implementation is dependent on the institution's administration, strategic plan, resource availability and staff attitude, amongst other human factors.

The higher education sector is overwhelmed with challenges of infrastructure for learning based on the current practice of traditional learning methods that require learning space (classrooms). Heavier investments are made in that area by most public universities, but we are beginning to see that budget line items for ICT infrastructure development are increasing. This is exemplified in the current Higher Education Science and Technology (HEST) project supported by the African Development Bank that has supported infrastructure development in public higher education institutions. Most of the institutions within this sector have adopted blended learning with the introduction of e-Learning to the existing teaching methods in the approved curriculum. Teaching, learning and research and outreach are core functions of the university, making them fundamental in the programming and activities of universities. Figure 2-2 is an attempt to situate learning at the centre of the activities that are supported by other elements. We emphasise technology use as a separate resource and infrastructure necessary to achieve learning in this era of information- and knowledge-driven society.

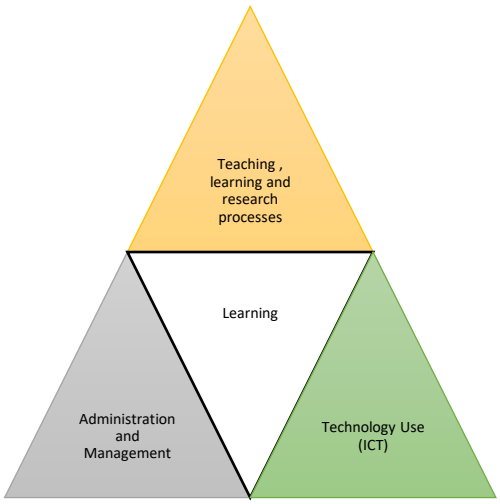

Figure 2-2: Situating learning at the core of university activities.

Education transformation is taking place with the motive of integrating new learning paradigms driven by economic, social and technological trends (Ayoo & Lubega, 2008). Innovative learning methods rely on the organisation of learning processes and infrastructures along with the teachers' ability to use technology to support pedagogical learning objectives that will lead to transformation of traditional methods (Ayoo & Lubega, 2008). Technology provides room for simulations, product design, testing and innovations leading to new areas of research and teaching. In response to the need to train teachers for employability and creativity, there has been a shift in pedagogical theory to constructivist theory upon which PBL is founded (Ayoo & Lubega, 2008; Dirckinck-Holmfeld, 2002; Savery & Duffy, 2001). Thus, the emphasis is now on productive learning that concentrates more on innovation, critical thinking and problem-solving supported by ICT.

2.3.4. STEPS TOWARD BUILDING INFRASTRUCTURE FOR LEARNING

All public universities receive support from the government and development partners through donor-supported projects. This is because government funding meant to support all sectors of the universities are not adequate to run the universities that are autonomous institutions that usually have to prioritise the use of such resources. Meanwhile, the development partners dedicate their resources to sections defined by the government or each institution.

Gulu University receives donor funding to support many aspects of its activities. The projects are mainly geared toward research capacity building at both institutional and individual levels but are also used for upgrading and or building new structures. Capacity building is a broad term that covers staff development, research and the research environment, and administration and management of the institution, while new structures include developing administrative structures and physical infrastructures. I concentrate my discussion on infrastructure for learning development as part of strengthening university capacity for research, teaching and learning.

Public universities receive grants from the African Development Bank through the government for upgrading infrastructure and facilities for research and teaching in universities. The HEST project is contributing to the development of new classrooms, research and teaching laboratories for physical and applied sciences, and the library and IT infrastructure backbone at Gulu University. Through this support, the university has designed the ICT master plan and is generally improving ICT infrastructure by a running fibre optic connection to all course centres, installing networking facilities on campus and providing basic training of IT staff in the management of this equipment. The HEST project follows an expert-led design that is user-centred (Sanders, 2002). This design process aims to develop products that

meet user needs; however, the user is not part of the team and is only required to provide information to the designers (Sanders, 2002) when it is needed.

The Swedish International Development Cooperation Agency (SIDA) project is purely a staff capacity development project funded by the Swedish government through Makerere University. The project also covers all public universities, concentrating on research capacity building through staff training at the postgraduate (Master's, PhD and post-doctorate) levels.

The collaboration between Gulu University and the University of New South Wales is developing staff capacity in pedagogy for the degree programmes. This project uses the ICT infrastructure to deliver training to teachers of the undergraduate programmes. The use of the ICT infrastructure for learning provides for further training of some of the staff in online course design and the basics of instructional design.

2.3.5. TRANSFORMATION OF HIGHER EDUCATION

By law, higher education is mandated to train human resources in all disciplines to respond to the need for employment in the country. Higher education is wider than university education as it covers specialised training institutions offering diplomas, degrees and postgraduate degrees. In universities, research is a vital part of teaching and learning that is now adequately enhanced through various technologies and ICT applications. The use of ICT can be experienced in all sectors and covers all core university activities. It has made many options of technology-enhanced learning, such as eLearning, virtual learning, situated learning, NL, collaborative learning and others, viable.

There are different conceptualisations and perspectives in learning. However, there are two different kinds of metaphors in respect to mediating learning – the acquisition and participation metaphors (Guribye, 2005). I will discuss these in Chapter 4. These descriptions are determinants of the decisions taken when adopting the use of ICT in a university. The use case scenario also defines the direction of the design and implementation of ICT infrastructure for learning.

2.4. RESEARCH SETTINGS

2.4.1. DOING RESEARCH IN UGANDA

It is a mixed experience to tell how nice in one way, and challenging in another, it is to conduct research in areas where research facilities are poor, but academics remain enthusiastic in their efforts to achieve individual scientific and institutional goals. At Gulu, staff are very interested in learning new ways of doing research using IT.

Conducting research in this environment is characterised by difficulties in programming, recruiting participants and data collection. ICT, however, also presents numerous challenges arising from technical ICT infrastructure, skills, diverse expert cultures and society cultural values and norms.

2.4.2. RESEARCH ENVIRONMENT

This research was defined within the confines of the BSU project that has been operating since 2011. The progressive improvement of the teaching and research environment, based on partnerships with development partners and academic and research institutions, set the agenda to research the design of infrastructure for learning in higher education. As I previously indicated, such collaborations are not new in Ugandan higher education, but the initiatives have not resulted in plausible results in the design of ICT infrastructure for learning (see Ssekakubo et al. 2011).

The project workshops served as sessions for collecting data on the need for transforming education through the introduction of PBL and eLearning (blended learning). The workshops were organised to provide a platform for all participants to be able to contribute to the discussion and to share their views as peers and colleagues. The project initially had Gulu University staff from the humanities and education, business and development studies, and peace and strategic studies, with some from science and IT support services. This highlighted the diversity of knowledge of teaching and learning approaches resulting from their backgrounds and experiences in the field of teaching.

Participation of the lecturers was voluntary, and there has always been an open call for participation through the project coordination office and other calls from the Institute of Research and Graduate Studies (IRGS), at least two weeks in advance. These calls are thematic and build upon one another with specific foci each time they are made. The target group of participants consisted of teachers, but administrators, who were also teachers in some of the programmes or responsible for academic affairs, were also active participants. Teachers and administrators who were open to participating in the workshops applied. Overtime, some consistent participants became the core of the workshops and built the critical mass of participants in the workshop series within the same theme of blended learning. By profession, the participants were distributed throughout the units as shown in Table 2-1.

Table 2-1: Core participants of the workshops by department.

Unit	No. Participants
Education	10
Business	12
Peace and strategic studies	05
IRGS	03
Science	05
IT support	02

It became necessary to provide certificates to all participants who actively contributed and attained some level of consistence in attendance. The level of consistence depended upon the workshop theme or what the organisers considered appropriate. Contributions and active participation were based on presentation triggers, discussions, feedback, peer assessment, reports etc. This was tied into the university promotion system, participant extrinsic motivation and production of a paper trail to showcase participants' contribution to the development of new ways of teaching and learning at the university. It would aid in promotion and enhancing their academic career or administrative position, which is also in line with institutional policies to develop new and redesign old programmes related to infrastructures for learning.

2.4.3. RESEARCH ENVIRONMENT CHALLENGES

Generally, infrastructure design is presumed to be an area for technical professions, such as engineers (civil, electrical, computer etc) and, more recently, IT experts. These are manifestations of design as a highly specialised activity of experts with the aim of creating tangible products or artefacts. Expert-led design of infrastructures has worked well in organising business processes based on people's expertise. However, a humanistic view of the design is lacking in these perspectives of engineering; thus, excluding the principle of participation in producing designs and implementations that contravene the use of such infrastructures is a basic challenge for the research environment. Design-based research in humanistic disciplines is a new frontier for researchers to engage in.

Other challenges associated with the lack of computer skills amongst the staff and students are glaring for many institutions, as reported in Bunoti (2011) who noted that

academics lack computer skills. Other challenging factors are management support, professional development, motivation, participation and accessibility to technology (Kafyulilo, Fisser, & Voogt, 2016).

Funding higher education by the government is another obstacle to a fair research environment in Uganda, as there is a wide funding gap. According to Bunoti (2011), only 30% of the required funding per student in higher education is normally released. In effect, this has led to poor planning and maintenance of existing infrastructure and quality of services at campuses. Somehow the institutions survive through collecting student fees. The fee structure at public institutions is somewhat controlled by government, so these institutions plan within their means (Bunoti, 2011).

Uganda is faced with the need to review strategies and methods that provide for the needed skill sets for graduates. This is in the context of a country experiencing high unemployment rates of about 40% (UBOS, 2015).

CHAPTER 3. INFRASTRUCTURE AND THEORETICAL CONCEPTS

This chapter introduces the concept of infrastructure from various perspectives. I ultimately relate the concept of infrastructure to learning in higher education in Uganda.

3.1. THE CONCEPT OF INFRASTRUCTURE

When thinking of infrastructure, we generally reflect upon things related to telecommunications, transport, buildings, hardware, engineering replicas and systems. According to Star and Ruhleder (1994), a common metaphor presents infrastructure as a substrate: something upon which something else operates. Infrastructure is something built and maintained, receding then into in the background or becoming invisible. This metaphor subscribes the infrastructure as a thing which in this case is accurate. They also noted that 'what can be studied is always a relationship or an infinite regress of relationships. Never a thing' (Star & Ruhleder, 1994 p.112).

Infrastructure may have several meanings depending on the professional background of the person speaking about it or the situation as to when and where it is referred to. For different people in different professions, infrastructure has unique conceptual meanings. It presents a complex situation, and because of these complexities, its boundaries cannot be generally defined (Guribye & Lindstrom, 2009). According to Star and Ruhleder's (1996) analysis, infrastructure is both relational and ecological, and it becomes infrastructure in relation to practices and not as a *thing* stripped of use. They imply that infrastructure should be defined by how that *thing* is used in practice. It is ecology of tools, actions and built environment, not just a technology, but aggregated and inseparable from social and non-technical elements (Lee, Dourish, & Mark, 2006; Star & Ruhleder, 1996). This perspective is more holistic as compared with limiting the perspective of infrastructure as merely technical and a thing. Guribye and Lindstrom, (2009) accordingly maintained that infrastructure is part of technological, material and social conditions of organised practices. These organisational practices are what we refer to in this work in education as teaching and learning.

3.1.1. DEFINING INFRASTRUCTURE

Infrastructure has been defined a set of resources (Star & Ruhleder, 1996) and as a relationship between a focal resource and supporting resources (Guribye, 2005). It is

perceived as transparent or as a black box that appears only when it breaks down. Infrastructure is thus sociotechnical and sociocultural in nature and includes organisation processes, social background knowledge, general acceptance and reliance and near ubiquitous accessibility (Jones, 2009). It is formed by use and is continuously undergoing development and growth based on the use cases. The use context and the practice therefore define infrastructures (Nyvang & Bygholm, 2010). Jones (2009) defined infrastructure in the digital environment as the notion of a sociotechnical system where social and technical aspects of the system are inextricably intertwined with technologies, and artefacts are closely connected with organisational and social practice.

The concept of infrastructure for learning could be used as a normative paradigm where, for a practice to work properly, one needs an infrastructure that transparently supports these practices (Guribye, 2005). However, some resources will have to be assigned to support these arrangements that can be either technological or non-technological or both.

3.1.2. DEFINING INFRASTRUCTURE FOR LEARNING

In relation to teaching and learning, Guribye and Lindstrom (2009) proposed that infrastructure for learning should refer to the interconnectedness of artefacts and to how such artefacts are themselves intermeshed with other technological, institutional and social arrangements. Therefore, infrastructure for learning in higher education must be understood in a complete way to include all business processes relating to the core functions. Guribye and Lindstrom (2009 p.105) defined infrastructure for learning as: 'An infrastructure for learning is a set of resources and arrangements – social, institutional and technical – that are designed to and or assigned to support a learning practice'.

In a learning environment, the pedagogical model adopted should relate to new tools and an IT environment which uniquely separates it from a case where technology is integrated before theoretically understanding how these could integrate with the pedagogical model (Guribye, 2005). A particular learning management system is designed in accordance with some kind of training or learning scheme which Wenger (1998) termed an *extractive training scheme*. Those schemes are deployed according to that pedagogy (Guribye, 2005). However, introduction of a tool into an existing infrastructure for learning can be challenging in terms of members' acceptance to engage with the tool because the tool can easily become the centre of focus rather than offering supportive functions to the work (Guribye, 2005).

For an organisational system to appreciate adoption of technology in its processes, it requires an in-depth understanding of the technical features, social context and culture of the workplace in which the technology is introduced. In many projects, these details

are implied by the managers and the technical staff of these institutions; thus, such details are mostly ignored in design and implementation. These complex organisation systems comprise a network that is supported by certain technological and organisational structures with the focus on the changing of these structures in relation to the professional practice (Nyvang & Bygholm, 2012).

The theoretical emphasis on complex relationships amongst social and technical aspects of infrastructure to provide insights into potential institutional effects and changes to individual work and life (Sawyer, Allen, & Lee, 2003) is vital in organising work processes. These situations are similar to what teachers are faced with in their work at universities. Thus, in higher education, technology is adopted as a tool to stimulate accomplishments of goals through flexible provision of services, sustainable growth and pedagogical advances (Sawyer et al., 2003).

Star and Ruhleder (1996) attempted to visualise many of the otherwise unexamined issues around infrastructures detailing the relationship nature of infrastructure. They stressed that it is important to understand the relationship between work/practice and technology. They examined important practices and institutional systems with which infrastructure are intertwined. These social practices were summarised by Star and Ruhleder as follows:

- **Embeddedness**: infrastructures operate depending on established technical and social structures upon which they are identified.
- **Transparency**: infrastructures do not require assembling or reinvention for each task which makes them invisible.
- **Reach or Scope**: infrastructure reaches beyond a single event of a one site practice, thus could be spatial or temporal.
- **Learned as a part of membership**: artefacts and organisational arrangements come to be taken for granted by members.
- **Linked with the convention for practice**: infrastructure both shapes and is shaped by the conventions of a community of practice.
- **Embodiment of standards**: infrastructures are modified by conflicting conventions; they take on transparency by plugging into other infrastructures and tools in a standardised fashion.
- **Installed base**: infrastructures depend on previous ones and on existing systems of support, funding, training and expertise.
- **Visible upon breakdown**: generally, when infrastructures break down, it is noticed; otherwise, it is mostly invisible. (p. 113)

3.1.3. CONCEPTUALISING INFRASTRUCTURES FOR LEARNING

To succeed in attaining a good environment for technology-enhanced learning, institutions need to operationalise structures and streamline and systematise mechanisms for investing and maintaining ICT infrastructure. However, often,

infrastructure for learning is not adequately planned, and when implemented, it then fall short of appropriate maintenance (Ssekakubo et al., 2011). It is however not clear why they often fail in higher education institutions. What is known is that most of the ICT projects are initiated in a top-down manner, thus limiting end user participation in the project conceptualisation (Ssekakubo et al., 2011). Although the success rate is low, infrastructures often do work to support the practice and workflows in higher education, which has led to research around this issue.

The current state of the University's ICT infrastructure for learning raises questions about its ability to deliver the twenty-first century skills (similar to the problem-oriented project pedagogy) to learners. The challenges span a range, including network availability and reliability; low bandwidth and subscription; technical expertise; and social and cultural understanding of infrastructure for learning. Therefore, this study's prerequisite goal was to document the state of infrastructures for learning in Uganda from technical, sociotechnical and sociocultural viewpoints. However, according to Ure et al (2009), studies show that research in infrastructure is left to the ICT researchers, and research in pedagogy is left to the educators, who are more or less concerned with the application layer of the infrastructure, and yet, in the university setting, the two complement one another. The study of infrastructure will show how infrastructure for learning can be co-designed with institutional stakeholders and across the boundaries of pedagogy and digitalisation and how it is used in higher education. The socio-technical approach works toward achieving appropriate alignment of co-evolving technical and human practice informed infrastructure (Ure et al., 2009).

New ways of teaching and learning require focus on infrastructure as a relationship amongst technology, educational practices, institution processes and knowledge for shaping educational practice with technology as expressed by Bygholm and Nyvang (2010). Further, they noted, implementation in higher education needs investigation to unearth viable infrastructure design requirements and conditions for acceptance strategies. Such design decisions and implementation strategies have always been left to the technical personnel (Ssekakubo et al., 2011) by institution management, rather than as a shared process by end users. Since infrastructure is socio-technical, they rely on integration of artefacts into institutional processes and features (Nyvang & Bygholm, 2010). Such integration is a sociocultural process that requires negotiation with attitude change. However, if neglected, it can result in tensions between technical and social issues of infrastructure (Ure et al., 2009).

3.1.4. INFRASTRUCTURES FOR LEARNING

Many studies, as reported in Ssekakubo et al. (2011), have been focusing on adoption, policy, regulations, socio-economic factors in adoption, technology barriers,

professional teacher development, but less emphasis has been given to infrastructure for learning in developing countries.

In designing infrastructure for learning, the real experts in the design process are the users and designers of such infrastructure, in which case they are students, teachers and managers. This category of users consists of the participants in the design process, and they define key aspects of the design. Teachers with knowledge of pedagogy in higher education and their perspectives on the use of technology for teaching and learning define the pedagogical idea and the content. The higher education system in Uganda is based on the teacher-centred approach in most programmes. Essentially, this approach has produced some skilled personnel in applied sciences, but mostly knowledge workers who mainly end up in white-collar jobs with less practical exposure. The dynamic work environment in the twenty-first century, where more skills and practical exposure are demanded of a university graduate in addition to knowledge, requires carefully researched, planned and designed infrastructure for learning environments. These innovations, skills, and creativity have been termed *twenty-first century skills* (Anderson & Shattuck, 2012; Bell, 2010; Jones, 2012; Teferra & Altbachl, 2004).

To address the need for these skills, other pedagogical approaches such as PBL and eLearning are now essential. Nonetheless, these new ways of teaching and learning come with the need for infrastructure redesign for effective knowledge acquisition or knowledge interaction. In the meantime, higher education institutions are faced with challenges of using their current infrastructure or redesigning the infrastructure to deliver new ways of learning. Designing infrastructure for learning requires re-engineering work processes (i.e. policies, curriculum), as well as both physical and human resources.

3.1.5. INFORMATION AND COMMUNICATIONS TECHNOLOGY AS INFRASTRUCTURE

The traditional concept of infrastructure that it is something ready to use, completely transparent and does not require further considerations, such as electricity, roads and rails, assumes a great deal about the user. This notion focuses on infrastructure as an object that is built and maintained and which later fades into the background (Jones & Dirckinck-Holmfield, 2009), and yet the activities around these infrastructures are shaped by their structure that defines their function. Thus, infrastructure is only seen when it fails in its function, especially digital infrastructure (the internet and data backbone). Otherwise, institutions want an infrastructure that primarily works to support their activities, such as teaching, learning, management and communications.

Edwards (2003) has described infrastructure as a sociotechnical system that relies on complex organisational practices for maintenance and for making it meaningful and ensuring that it is a widely shared, human constructed resource. The notion of sharing

is significant to this work because, in higher education, all resources are created and shared as part of knowledge and work toward innovativeness. This is based on the infrastructure's design and redesign to focus it on business processes and development (Jones & Dirckinck-Holmfield, 2009). In relation to ICT, Star and Ruhleder's work has shown that ICTs are interpreted as infrastructures that shape and are shaped by practice. The practice enables infrastructure to be understood as a relational concept that only when artefacts are used and become part of practice are they recognised as infrastructures (Star & Ruhleder, 1996).

University teaching and learning have always involved the use of artefacts, planning and preparation, which are considered prototypes of design for learning (Jones & Dirckinck-Holmfield, 2009). A skilful and creative activity open to continuous improvement and development is a design activity relating to pedagogy, content and infrastructure for learning (more so in IT). The design of technological and institutional infrastructure for learning is a process that creatively and collaboratively produces a design/plan for systematic implementation. In this thesis, the definition of infrastructure as in Edwards (as cited in Bygholm and Nyvang, 2009) as implying not only hardware but also organisation, general acceptance, socially communicated reliance and near ubiquitous accessibility is adopted, thus considering infrastructure as a relation (Star & Ruhleder, 1996).

3.1.6. HUMAN INFRASTRUCTURE

The nature of infrastructure can be a debatable issue for scholars, but according to Lee et al. (2006), it is the underlying framework that enables a group, organisation or society to function in certain ways, much like a water system. Further, they referred to infrastructure to mean ways in which human and organisational arrangements share properties with IT infrastructures. Human infrastructure, rather than being amorphous, was described by Lee et al (2006) as 'multimorphous' – holding more than one shape at once and also dynamically changing shape overtime. They argued that its multimorphous nature is the underlying framework for the big science collaboration, and that the flexibility of human infrastructure is its strength which allows for it to robustly meet its demands This implies that human technical abilities to organise and use these artefacts in daily practice are as important as any man-made infrastructure itself.

Human infrastructure is explored in this work to understand how human resources (teachers, technicians and administrators) in higher education utilise technology in their practices and how the process of teaching and learning can be enhanced by IT infrastructure. This concept of human infrastructure originated from the concept of infrastructure in Computer-Supported Collaborative Work (CSCW). Thus, this will not only reveal the relationship between social groups and infrastructure, but also

examine these social groups themselves as infrastructure (Lee et al., 2006). The majority of studies related to infrastructures and specifically infrastructure for learning have tended to focus attention solely on technology infrastructures (Sambasivan & Smyth, 2010), and in other cases, they are discussed from a socio-cultural perspective. Human infrastructure (Lee et al., 2006) refers to the arrangements of organisations and actors that must be brought into alignment for work to be accomplished. Lee et al. (2006), building on the concepts of 'community of practice' (Wenger, 1998), argued that infrastructure shapes and is shaped by the routines of a community of practice, depending on previous routines and on existing systems of support, training and expertise.

3.1.7. THE LIBRARY AND E-RESOURCES

To combine the power of collaboration with ICT, the library resources are essential and have to be available and accessible to the learners and educators at department levels. This provision has to afford real-time access, which would come with reliable services based on the IT infrastructure. Some of these services have to be guided by the pedagogical model in play, such as PBL, where access to online electronic books, subscription to electronic journals and knowledge sharing environments for local content are important to the learner's development. Also, sound academic resources for staff are at the centre of designing learning objects and projects that could align with the community priorities.

Designing for learning is informed by eResources and other library resources that are central to learning. These resources guide the design of curricula and the pedagogical approach adopted by the institution. Library resources therefore form part of the object of design and implementation of a learning infrastructure. Gulu University has these resource requirements in its infancy stage.

3.2. PEDAGOGY AS A DRIVER FOR INFRASTRUCTURE DEVELOPMENT

Conditions within the universities could affect the practice of teaching and learning by stakeholders and how they use information and communications technology. Thus, the IT infrastructure needs to align with the pedagogy for its design and application to be relevant to the domain where it is employed.

3.2.1. PEDAGOGY AND ICT

The ultimate goal of building ICT infrastructure (computers, internet bandwidth, software and applications) is frequently decided in opposition to key pedagogical focuses or advantages (substantiated by theory of learning) that should drive the need for technology to enhance, support and transform learning and teaching activities (Guribye, 2005). However, the application of ICT in education, although it has matured in the West, is still marginal in academics in developing countries (Conole, 2004).

3.2.2. NETWORKED LEARNING

This is a broader concept in which ICT is used to promote connection between learners themselves, educators, and the learning community and its learning resources (Jones & Dirckinck-Holmfeld, 2009). The concept requires a focus on infrastructure as a relationship amongst technology, educational practices, organisation and knowledge involved in shaping educational practice with technology (Bygholm & Nyvang, 2009). Bygholm and Nyvang and Jones and Dirckinck-Holmfeld (2009) have argued for further research in organisational issues relating to implementation in higher education as a determinant for essential conditions leading to viable designs for adoption strategy. This positions the study of infrastructure between micro- and macro-levels in an organisation, which they have referred to as the meso-level, where change is collaboratively driven (Bygholm & Nyvang, 2009).

3.2.3. BLENDED LEARNING

In this research, blended learning is considered an integrated approach which includes PBL and eLearning. This is because the two approaches are concurrently introduced in the project.

To understand the teaching and learning process resulting from the introduction of e-learning and PBL at Gulu University, participatory design was adopted and operationalised in studying the perspectives of teachers (Zander, Georgsen, & Nyvang, 2007).

3.2.4. ELECTRONIC LEARNING

Electronic learning, or simply eLearning, is the exploitation of IT capability to learn outside of the traditional classroom through access to formal curriculum. eLearning has expanded significantly due to the rapid growth of the internet, e-learning

initiatives and supporting policies (Conole, 2004) and has evolved as a means of empowering and fully engaging students in learner-centred learning and NL. E-learning is therefore about supporting technologies for content delivery and for making learning experiences in all settings more effective, efficient, attractive and accessible for learners (Koper & van Es, 2004). With the current advancement in the internet and mobile technologies, it has promoted peer collaboration through groups actively engaged with content, therefore creating and sharing knowledge within learning communities. However, eLearning is still marginal in the life of most academics (Conole, 2004) in developing countries, with technology such as learning management systems rarely being used as a content repository by educators.

Several virtual learning projects in developing countries that were implemented did not meet their full potential (Ssekakubo et al., 2011) because they fall short of meeting basic instructional goals and objectives. However, some studies noted that e-learning tool evaluation for supporting distance education revealed 50% of learners adhere to its advice (De Leng, Dolmans, Muijtjens, & Van Der Vleuten, 2006). The key is developing clear goals in relation to a chosen pedagogical model. Once a pedagogical model is defined (as in the case PBL), the design of infrastructure for learning is based on its principles. Similarly, there is need to train instructors for effective online instruction and student engagement and the number of instructors should match with institutional implementation strategy. Monitoring students' online activities through regular feedback and scaffolding could improve skills for online teaching.

Critical success factors for implementation of e-learning, according are closely related to the instructor, student, IT services access, and institutional efforts. Pedagogically, De Leng et al. (2006) suggested that an investigation of any useful effects of virtual learning should address interaction and information gathering in all phases of PBL which should incorporate an instructional design methodology. This links the design of the learning organisation to the foundation of the design of the infrastructures therein.

3.2.5. PROBLEM-BASED LEARNING

The idea of learning by managing problems is not new, and the development and adoption of PBL reflects several historic understandings of learning and shaping higher education philosophy and systems. PBL is an instructional learner-centred approach that empowers learners to conduct research, integrate theory and practice and apply knowledge and skills to develop viable solution(s) to a clearly defined problem (Savary, 2006). While problem-solving ability is a critical skill for learning in higher education, skilful problem formulation ability is an even more critical competence (Dirckinck-Holmfeld, 2002). PBL is focused, experiential learning

organised around the investigation and resolution of messy, real-world problems (Savery, 2006).

Originally designed to respond to criticism that traditional teaching and learning methods fail to prepare students for problem-solving and problem formulation, PBL is perhaps the most innovative instructional method in education (Dirckinck-Holmfeld, 2002) today. However, PBL ties students learning process to real-life problems making it a suitable pedagogy for developing countries. Accordingly, it has been applied globally in many professional domains, such as architecture, engineering, science, business administration, law, social works, education etc.

PBL is underpinned by the theory of situated learning with the primary goal to enhance learning by requiring learners to formulate and solve problems. This pedagogy is characterised by student centeredness, self-directedness, self-reflecting, problem focused collaboration and facilitated learning. However, it has been criticised for its emphasis on higher order thinking and problem formulation/solving skills at the expense of lower level knowledge acquisition.

When learners are responsible for deriving meaning from their interaction with contexts from which they are learning, knowledge that is anchored in specific context is more meaningful, integrated, better retained and more interactive. Additionally, problems and/or scenarios provide a purpose and motivation for learning. Without an intention to learn, which is provided by problems or projects or scenarios, meaningful learning rarely occurs (Hung, Jonassen, & Liu, 2008).

Higher order thinking is an important cognitive skill required for developing sophisticated problem-solving skills and executing complex ill-structured problem-solving processes (Hung et al., 2008). Thus, to be an effective problem-solver, students need to possess analytical and critical thinking and meta-cognitive skills. Hung et al. further affirmed that articulating problem spaces requires analytical skills, evaluating information involves critical thinking skills and reflecting on one's problem-solving process requires meta-cognitive skills. Collaborative learning is an essential element of PBL; however, utilising it in instruction is theoretically sound, but may not be as straightforward because there could be many forms of collaboration. Collaborative learning should therefore be accounted for in the design of the infrastructure for learning, thus requiring user-centred design decisions.

PBL and e-Learning are effective means of providing learners with problem-solving skills, flexible knowledge, collaboration skills, intrinsic motivation and self-directed learning (Kolmos, 2009). These values that are packaged within the pedagogy make it relevant for modern higher education training for employability and job creation. I present the PBL in Chapter 7 on its own as the foundation for designing the infrastructure for learning at Gulu University and linking it to the BSU project.

3.2.6. PBL PEDAGOGY AND INFRASTRUCTURE FOR LEARNING

Considerable research has been done in the field of pedagogy and infrastructure for learning and the connection between pedagogy and technology. Pedagogy is often authenticated by theories of learning and learning principles that support those theoretical foundations. A theoretical approach based on the pedagogy should inform the design, acquisition and implementation of infrastructure for learning in all higher institutions of learning. As reported by Guribye (2005) in his ethnographic enquiry into the social and technical conditions of education and training, building IT infrastructure is commonly seen in opposition to a pedagogical focus that should define the need for technology to enhance instruction or activities relating to learning. According to Guribye, the design and implementation of technological tools are in response to learning theories in order to entrench theoretical knowledge in the application of these technologies. Such applications can be exemplified in learning environments, such as Moodle, which are professionally designed based on a strong theoretical foundation to support nearly all aspects of learning as required in the twenty-first century. There are, of course, many other popular applications, including Blackboard, Google Classroom, and others that are less popular in higher education in Uganda, such as Docebo LMS, Joomla LMS, etc. that might have strong theoretical foundations. However, some people even use social media platforms as inspiration for students and staff to consider adopting technology-enhanced learning in the teaching and learning. Other researchers have also tried to map pedagogical approaches and theories onto applications of learning technologies (Conole, Dyke, Oliver, & Seale, 2004), such as in a situation of blended learning. There is also the situation where technology is often introduced after the learning has already been approved, based on a different pedagogy. Teachers' level of commitment and creativity in a teacher-centred learning environment would determine the success of such approaches.

The introduction of PBL pedagogy at Gulu University, which has from its inception used traditional teacher-centred approaches, implies that the respective faculties have now added a new approach to its theory of learning. PBL based on the constructivist philosophy that knowledge is socially constructed when groups of learners engage with real-time problems that affect communities requires new infrastructure for learning or simply redesigning with the theoretical perspective. If aiming to create an environment and system that will produce responsible citizens who completely understand the theory and can adequately apply it to societies, the education system should allow for the creation of expert knowledge to innovate, collaborate, critically examine and offer possible solutions. Developing skilled human resources into agents of social change (Roy, Kihoza, Sihonen, Vesisenaho, & Tukiainen, 2014) and improving employability (Kolmos, 2009) are essential. The need for another pedagogical approach that promises to meet these criteria is the goal (I discuss PBL in a complete chapter later). To explain the further need to accommodate for

technology-enhanced learning, I will explicate the need for an infrastructure for learning design that captures the sociocultural and sociotechnical perspectives.

Some of the technological challenges and opportunities are emerging through the social media, and I would like to explain these in relation to resource constrained settings. This is one of the main areas where students engage with learning materials along with social activities with their peers.

3.2.7. SOCIAL MEDIA USE IN HIGHER EDUCATION

Social media have since their introduction over a decade ago have come to dominate ways in which IT is used worldwide. With a variety of forms, such as Facebook, YouTube, Twitter, WhatsApp, Wikipedia, blogs etc., social media have drastically changed how people from all social and cultural backgrounds communicate and use the internet. The simplicity of their design and principles does not warrant any formal user training other than basically knowing how to use ICT artefacts. These platforms have led to a lot of interaction, both horizontal and vertical, within the public domain. This has allowed everyone the opportunity to share with anyone a topic of interest for as long as the connection is established.

All these Internet applications rely on openly shared digital content that are authored and critiqued by many users allowing for unlimited possibilities to interact and share all forms of content (Selwyn, 2012). The strength of such a system is derived from its mass socialisation characteristics, thereby attaching to the power of collective actions of its user communities and allowing for synchronous communication (Selwyn, 2012). The resulting effect is that we begin to see the participatory use of these applications and collective activity relating to collaboration, creativity and innovation users. The activities represent some kind of rudimentary learning curve that each individual user attains over time. It could be learning to voice their feelings, communicating, social interacting, attaining independence through debate, self-organising and time managing etc. The social media are accordingly an open system based on a bottom-up development approach (Selwyn, 2012), thus giving users democratic powers to defend their views openly in discussions and explore topics of their choice.

Higher education is now faced with the predicament to redefine its policies and participate on these platforms to engage with its users in a more objective way (Selwyn, 2012). Application of the social media presents some learning opportunities since its user communities are massive. The number of users and applications have considerably increased over the last 10 years (Selwyn, 2012). I have noticed that teachers are considering the possible implications of social media for higher education. This is based on the reasoning that they present a dynamic nature of interaction, and new types of learners within universities and those joining are prevalent, irrespective of age or status in society. They have penetrated campuses and influence many aspects of students' lives (Yu, Tian, Vogel, & Chi-Wai Kwok, 2010).

The established connections amongst learners present them with the potential for multitasking, flexibility and creative ways of learning (Selwyn, 2012). These platforms, if I can relate them to learning in higher education, have brought learning activities closer to all learners and have provided independence to learners to self-organise, as well as offering choice, convenience and control to design, produce and quickly distribute products on the social network (Selwyn, 2012).

It is apparent that the increased presence of social media is now an essential communication infrastructure for universities to connect with students and keep the conversation flowing. Studies (Selwyn, 2012; Yu et al., 2010) have shown that student orientations in universities are now being done through social media, emphasising various kinds of peer-to-peer learning and sharing resources. There is now academic work such as sharing audio-visual teaching materials that take place on social media platforms. However, challenges here are ethical issues and data integrity.

CHAPTER 4. RESEARCH DESIGN

This chapter discusses the theoretical framework adopted in this research project and presents the researcher's position as a summary.

In designing learning environments, designers focus on identifying features of the setting in which educators organise future activities and plan for expansion (Jones & Dirckinck-Holmfeld, 2009). There are several theories and concepts that can be used to concretise theoretical underpinning of this research. Looking at infrastructure for learning, I focus on the concept of human and technology praxis to understand the sociocultural and sociotechnical issues in infrastructure for teaching and learning. I will discuss the paradigms and later the choice of participatory design.

In presenting research design, it is important to start the account with an overview of research paradigms upon which research design, methodology and methods are connected theoretically.

4.1. SELECTING THE CASE

This research project was designed within the context of a two-year collaborative project between Gulu University and a consortium of Danish universities entitled the BSU project.

4.1.1. BUILDING STRONGER UNIVERSITIES

This project aimed at strengthening the capacity of universities in developing countries like Uganda. The project had two phases successfully completed with the third phase in its initial stages of implementation at the time of writing. In the first and second phases, universities from five countries (Nepal, Kenya, Tanzania, Uganda and Ghana) participated in the project. For various reasons, Kenya and Nepal did not continue into the third phase. However, based on the situation and the need of these universities, the research and capacity building addressed a unique niche of each institution. The common area of interest to all institutions has been staff research capacity building at both individual and institutional levels. The institutions were grouped on platforms that defined their collective need. In this case, Gulu University (Uganda) was positioned on the same platform with Tribhuvan (Nepal) and Maseno University (Kenya) for Stability, Democracy and Rights (SDR), and was the only institution participating in the third phase.

4.1.2. BSU AT GULU UNIVERSITY

In the quest to improve core functions of teaching, research and community outreach, the BSU capacity building project contributed to training staff, students and administration of the university in a new pedagogy, supporting establishment of structures and building infrastructures for learning in the university resulting in the introduction of PBL and eLearning at the graduate level.

The project was conceptualised and designed to support Gulu University in its efforts to strengthen research capacity at the PhD level (individual) and research-based education with an emphasis on community transformation. It was clear at the project initiation that staff training at the PhD level was at its infancy and that the university was operating with very limited resources. The project had quality, equity and innovation as thematic areas in the second phase which aligned well with the need to introduce PBL and blended learning as a way of achieving research-based education. The pedagogy of PBL is seen as one of the ways to deliver on the goal of community transformation through interventions by students and staff working together with communities in addressing community problems. As the region recovered from the Lord's Resistance Army (LRA) war and encampment, the university committed to outreach and community engagement to be able to positively impact on communities. Collaborative research projects were therefore formulated amongst senior researchers from Danish universities and Gulu University staff to strengthen the research capacity at both individual and institutional levels.

In phase one of the BSU, the project was awarded a communications grant as part of the effort to strengthen collaboration amongst partners and build infrastructures and communities of practice around staff professional expertise and online communities. This project introduced partners to online learning environments and open web-based services for collaboration and data sharing. It initiated participation in academic activities organised around the themes based on the research interests of the staff. Challenges with ICT were identified by the partner institutions and were documented (bandwidth, eLearning infrastructure, staff ICT skills and general lack of policies).

In the third phase, the project design was based on the theory of change. The changes were planned to be systematically implemented through collaboration between academic staff at Gulu University and the consortium of Danish universities. As part of this collaboration, the project and university were to enhance, upgrade and use research infrastructure and administrative systems to benefit Gulu University. The strengthening of ICT, PBL and e-learning at Gulu University that was initiated in phase II had provided the springboard for these changes that could be followed over time.

The practice of jointly teaching PhD courses and undertaking collaborative research and knowledge exchange with local communities was expected to contribute to

improved capacity for action research and the strengthening of research capacity. Orienting the project toward community engagement was expected to enhance research, teaching and supervision of postgraduate programmes.

It was envisaged that collaborative research would address community challenges through action, knowledge exchange and PBL. Through linking selected collaborative action research projects to PBL courses and to individual research projects, outreach would be better integrated into teaching and research. Thus, the project was designed to enhance capacity for outreach at both system and individual levels. This project was the basis for selecting the case for this research.

4.2. RESEARCH PARADIGMS

Paradigms are often used interchangeably with philosophical worldviews. They are sets of philosophical assumptions and beliefs that systematically guide inquiries (Creswell, 2003) or are referred to as a loose collection of logically related assumptions, concepts or propositions that orient thinking and research (Mackenzie & Knipe, 2006) or the philosophical intent or motivation for doing research. The term *worldview* means a basic set of beliefs that guide action, according to Mackenzie and Knipe. Mac Naughton et al. (2001) offered this definition (as cited in Makenzie and Knipe, 2006) as composed of three elements: 'a belief about the nature of knowledge, a methodology and criteria for validity' (p. 2). Another term is *theoretical framework*, which is also sometimes referred to as a paradigm, as described by Mackenzie and Knipe (2006). They further noted that this framework influences the way knowledge is studied and interpreted, and that the role of paradigms varies from research to research, and many times its role has been mysterious or has different emphases. However, they argued, the choice of paradigms determines the intent, motivation and expectation for the research, and paradigms therefore set the basis for subsequent choices regarding the methodology, literature and research design.

Research (theoretical) paradigms that are commonly discussed in the literature are positivist (post-positivist), constructivist, interpretivist, transformative, emancipatory, critical and pragmatic paradigms (Mackenzie & Knipe, 2006). I attempt to briefly discuss these theoretical paradigms in general and specifically focus in detail on those which guided this enquiry process.

4.2.1. POSITIVIST OR POST-POSITIVIST PARADIGM

The positivist paradigm is based on rationalistic, empiricist philosophy and reflects deterministic philosophy in which causes determine effects and/or outcomes (Mackenzie & Knipe, 2006). Positivism is applied to studying the social world with

the assumption that the social world can be studied in the same ways as the natural world and that the methods used are value free so that explanations of connection can be provided (Mackenzie & Knipe, 2006). 'The social is seen as an object that can be studied and that positivism assumes that social phenomena can be approached with scientific method and makes a number of assumptions about the world and the nature of research', according to O'Leary (2004, p. 5). This is more often applied in the natural and applied sciences. The 'aim is to test theory or describe an experience through measurements and observation' (p. 5) so as to model and predict and control behaviour around the study.

In positivism, it is believed that the world is a definite entity whose mysteries are within human comprehension (O'Leary, 2004). It is also believed that humans can know the world (knowable), that what is not yet known will be known in the future with the advancement of technology, that there are laws and theories that can regulate the world (predictable) and that there exists some truth that is applicable to all (singular) (O'Leary, 2004). The assumption in positivism and post-positivism is that all research is guided by a well-developed set of theories 'apart from the one that is being tested' (Mackenzie & Knipe 2006, p. 3). Theories are known to be provisional and new knowledge or understandings may challenge the entire theoretical framework, according to Mackenzie and Knipe. In a rational understanding of how the world functions and knowledge is produced, 'Positivism is the view that all true knowledge is scientific and can be pursued by scientific method' (O'Leary, 2004, p. 10).

4.2.2. CONSTRUCTIVIST PARADIGM

According to Mackenzie and Knipe (2006), constructivist/positivist paradigm emanated from Husserl's phenomenology and Dilthey and other philosophers' study of interpretative understanding of hermeneutics (Mertens, 2005, as cited in Mackenzie & Knipe, 2006). Constructivist researchers rely upon the participants' views of the situation under study and recognise the impact based on their background and experiences (Mackenzie & Knipe, 2006). Constructivist theory therefore provides a balanced representation of views from the community or participants on the situation under investigation. Researchers develop theory or patterns of meanings during the research process implying that, in most cases, the researcher relies on qualitative data collection methods and analysis (Mackenzie & Knipe, 2006), in which case, the knowledge and reality are socially constructed in multiple ways. Thus, it assumes that knowledge is socially constructed by people active in the research process and that the researcher attempts to understand the complex world of lived experiences from the point of view of those who live it (Mertens, 2010). MacKinnon and Scarff-Seatter (1997) wrote that constructivism is a learning or meaning-making theory where individuals create their own new understanding based upon the interaction of what they already know and the phenomena or ideas with which they come into contact.

Constructivism has been described as a descriptive theory of learning and that interpretivist/constructivist paradigm research focuses on making sense of the meanings that others have about the world.

In the constructivist approach, researchers focus on the process of interaction amongst individuals and on the specific context in which individuals live and work, and they accept that their own background shapes their interpretation (Creswell, 2003).

4.2.3. TRANSFORMATIVE PARADIGM

The transformative paradigm is one that came out of theories such as critical theory, expansive learning (Engeström, 1991) and others. This paradigm emerged particularly due to dissatisfaction with existing dominant paradigms and practices, and also to answer to sociological and psychological theories that were being developed. These theories were relatively oriented to and are based on masculinity (Mackenzie & Knipe, 2006). The transformative paradigm therefore provides a critique of both the positivist paradigm and constructivist paradigm that focused more on the individual and less on the critical societal structures such as power structures. The feeling of these researchers was that the constructivist approach did not completely address some of the issues of social injustice and marginalised peoples (Creswell, 2003), and that inquiry has to be intertwined with politics and contain an action agenda for reform that may change the lives of participants or institutions in which these individuals work and thus ultimately where the researchers live (Mackenzie & Knipe, 2006). Data requirements for this kind of research are much the same as those in the case of the interpretivist/constructivist paradigm, although a mixed method in this case provides the research with the structure for the development of a complete social world because of the multiple perspectives involved (Mackenzie & Knipe, 2006). Transformative research can also be referred to as participatory action research which aims at bringing change in practice, and, in which case, participants are considered as colleagues in the research. Participatory action research, which I will present later, may be viewed as an example of the transformative research approach as the aim is to understand current practice and transform it into a user defined work practice.

4.2.4. PRAGMATIC PARADIGM

Pragmatism originated in the United States and is associated with philosophers such as Charles Sanders Peirce, John Dewey and William James (Anderson & Shattuck, 2012; Creswell, 2003). This paradigm is independent in that it does not subscribe to any one system of reality (Mackenzie & Knipe, 2006). These researchers rejected the scientific idea that social enquiry can lead to the ‘truth’ about the real world through a scientific method. Rather, the researchers tended to focus on the ‘What’ and the ‘How’ of the research problem (Creswell, 2003), thereby providing the underlying

philosophical framework for mixed-method research (Mackenzie & Knipe, 2006). Pragmatic research thus places the research problem at the centre and attempts to apply all other approaches to understanding that problem (Creswell, 2003). In its attempts to understand the problem, it does not prioritise an approach to knowledge in terms of metaphysical questions about ontology and epistemology. Ontology is the beliefs about the nature of being and what is known about the reality, while epistemology is the nature or knowledge and how it can be acquired (Ritchie & Lewis, 2014). This reality, from a pragmatic standpoint, is renewable in that new decisions and actions can be taken in a new situation. Everyone has beliefs about the nature of reality, and those beliefs are subject to change and contextualisation.

As the pragmatic approach focuses on the method that would work best, it is believed that there is no such approach that is unique to study a problem. Yet, some emphasis should be placed on choosing the most appropriate method that adequately addresses the research problem. Data collection and analysis methods are selected based on whichever will provide insights into the research question without philosophical loyalty (Mackenzie & Knipe, 2006). In pragmatism, researchers perceive and interpret consequences of their actions, so it is more of a matter of belief rather than reflection of some unknown reality. Reality is put into action, and it is often implicitly interpreted whether or not the outcomes were expected. Depending on the results, the original belief is upheld or reconsidered. Our perceptions and understandings of outcomes are based on our own constructions, which in some ways lead to epistemological constructivism. This makes actions, beliefs and interpretation of results, compared with the original belief, the one most important thing. Thus, the concept emphasises focusing on issues of research around human experience rather than on debates about the nature of reality or other matters (Ritchie & Lewis, 2014). What might be disturbing here is that subjective perceptions must exist as mediators between and external reality and any kind of action. Otherwise, dealing with dilemmas and contradictions are common to all research paradigms.

In summary, these paradigms were presented in a simple table with key features (see Coto, 2010, p. 81) or characteristics as in Table 4–1.

Table 4-1: Research paradigms.

Paradigm	**Key features**
Positivist/post-positivist	• 'Reflects a deterministic philosophy in which causes probably determine effects or outcomes' (Creswell, 2003, p. 7) • Aims to test a theory or describe an experience 'through observation and measurement in order to predict and control forces that surround us' (O'Leary, 2004, p. 5).

	• 'Post-positivists work from the assumption that any piece of research is influenced by a number of well-developed theories apart from and as well as, the one which is being tested' (Cook & Campbell, 1979, p. 2) • Commonly aligned with quantitative methods of data collection and analysis.
Constructivist/Interpretivist	• Has the intention of understanding 'the world of human experience' (Cohen & Manion, 1994, p. 36) • 'Reality is socially constructed' (Mertens, 2005, p. 12) • Researchers tend to rely upon the 'participants' views of the situation being studied' (Creswell, 2003, p. 8) • Researchers recognise the impact of their own background and experiences on the research • Relies on qualitative data collection methods and analysis or a combination of both qualitative and quantitative methods. • Quantitative data may be utilised to support the qualitative data.
Transformative	• Transformative researchers felt that the interpretivist/constructivist approach to research did not adequately address issues of social justice and marginalised peoples (Creswell, 2003, p. 9). • Transformative researchers 'believe that inquiry needs to be intertwined with politics and a political agenda' (Creswell, 2003, p. 9) • Research contains an action agenda for reform 'that may change the lives of the participants, the institutions in which individuals work or live, and the researcher's life' (Creswell, 2003, pp. 9–10). • May utilise a mixed-method approach, allowing for an understanding of 'greater diversity of values, stances and positions' (Somekh & Lewin, 2005, p. 275)
Pragmatic	• Pragmatism is not committed to any one system of philosophy or reality. • Pragmatist researchers focus on the 'what' and 'how' of the research problem (Creswell, 2003, p. 11).

	• Places 'the research problem' in the centre and applies all approaches to understanding the problem (Creswell, 2003, p. 11). • With the research question as 'central', data collection and analysis methods are chosen as those most likely to provide insights into the question with no philosophical loyalty to any alternative paradigm.

Note: Information extracted from Mackenzie & Knipe (2006). Source: Coto (2010, p. 81), adopted from PhD thesis.

According to Mackenzie and Knipe (2006), terminologies used to discuss paradigms can be overtly confusing because they depend on the author orientation. Thus, they defined specific research paradigms based on their particular features which differentiate them from other paradigms within the same group. Detailed terms associated with each of the paradigms are summarised and presented in Table 4-2.

Table 4-2: Paradigms and their associated languages.

Positivist/Postpositivist	**Interpretivist/ Constructivist**	**Transformative**	**Pragmatic**
• Experimental • Quasi-experimental • Correlational • Reductionism • Theory verification • Causal comparative • Normative	• Naturalistic • Phenomenological • Hermeneutics • Interpretivist • Ethnographic • Multiple participant meanings • Social historical construction • Theory generation • Symbolic interaction	• Critical theory • Neo-Marxist • Feminist • Critical race theory • Freirean • Participatory • Emancipatory • Advocacy • Grand narrative • Empowerment • Change-oriented • Interventionist • Queer theory • Race specific • Political	• Consequences of actions • Problem-centred • Pluralistic • Real-world practice oriented • Mixed models

Note: Adopted from Mackenzie and Knipe (2006, p. 5).

Considering that design generally is a collaborative process involving several stakeholders, the theory underpinning research would be based on the both the constructivist paradigm and, to some degree, the pragmatic paradigm. To understand the purpose of designing infrastructure for learning, the participants are required to participate and construct meanings of the design based on how it will enhance their

teaching practice. The participants in the design process would construct meaning of the infrastructure depending on the social and historical context in which they use these infrastructures in the university. The understanding of infrastructure for learning and the new ways of teaching and learning are strongly embedded in the sociocultural perspective of the teachers. This understanding informs the decision on how the design will be achieved and the requirements for the infrastructure based on the user-perceived usability of the system. Similarly, it is based on the need to develop new ways of teaching and learning based on the introduction of blended leaning for which the implementation would follow a pragmatic paradigm. Furthermore, the implementation of the design would require technical intervention to produce prototypes for the user to interact with the would-be system. Thus, pragmatism enables users to appreciate their ideas based on the resulting product of the design. This would affirm Dewey's principle of consequences as a result of an idea (Karagiorgi & Symeou, 2005) of training and exposure relating to solving a real-world problem. If the process knowledge is collaboratively constructed by participants, as well as facilitating the change process, that in the end would lead to transformation of the teaching and learning in the university – thus, transforming education.

4.3. THEORETICAL FRAMEWORK

The theoretical framework is complex and brings together theories, which are situated in these broader paradigmatic frameworks of positivism, constructivism, pragmatism and transformation. The theoretical framework adopted in this research combines the 1) sociotechnical and 2) sociocultural perspectives in the study of infrastructures for learning. The position of infrastructure for learning, as I discussed earlier, is envisioned as consisting of technical, social, and cultural factors. In this research project, we appreciate the sociocultural and sociotechnical perspectives of infrastructures for learning with emphasis on user participation as a motivation for an inclusive and sustainable infrastructure for learning in a resource constrained setting. Taking the two more social science approaches to researching into infrastructure for learning is based on the fact that there are overarching issues that cannot be solved by a single method. Research that is intended, in part, to understand organisational change in practice requires adequate user participation. Thus, designing infrastructure for learning requires a high level of end user participation from the onset. This process is layered with cultural activity theory attempting to transcend dichotomies of micro and macro, material and mental and observation and intervention in the analysis and redesign of work (Engeström, 2000).

In the following sections, I begin by presenting the main principles of sociocultural and sociotechnical perspectives and then describe the theoretical framework for the study.

4.3.1. SOCIOTECHNICAL PERSPECTIVE

The sociotechnical system's perspective is a result of studies of workplaces that were done after World War II in the UK. This resulted in the understanding that the introduction of system engineering into the organisation was not providing the desired effects on productivity (Bannon & Ehn, 2012). This was the least expected outcome of a computerised system that went through the rigor of systems development. This finding, which relates to the lack of attention to the social subsystem while developing the technical subsystem, led to the development of an inclusive approach to work reorganisation with a focus on the social subsystem (Bannon & Ehn, 2012). However, system design has often been related to technical objectives which were challenged to include organisational contexts and human (user) contexts (Mumford, 1983). That finding was a contradiction to the technological imperative of work design where all activities were planned and implemented by specialised engineers whose goals and priorities were to fit the personnel to the requirements of the technology and not the other way round (Bannon & Ehn, 2012). Bannon and Ehn (2012) asserted that the assumption was that improving socio-economic conditions of work through human relations activities would address the challenges of this approach, which never came to be. In the end, 'alienation remained in organisations where the social and the technical aspects of work had been treated as completely separate domains' (p. 42). To allow for equal treatment of the perspectives, they noted, organisations began to be viewed as sociotechnical systems, instead of as their separate parts. The organisation can then be studied through action research, they asserted, or simply through participatory action research (Mumford, 2006). This allows all groups associated with the design outcomes to be involved in the process, therefore presenting their interests in the design. According to Mumford, the design product is 'strong technically and in human terms; the design decision is taken on the basis of a continuing dialogue with individuals and groups who will use and are affected by the eventual system' (Mumford, 1983, p. 47).

Sociotechnical systems design methods are approaches to design that consider integrated human, social and organisational factors, as well as technical factors in the design of organisation systems (Baxter & Sommerville, 2011) that partly inspires the methodological approach. They describe a process and a humanistic set of principles in the context associated with technology and change (Mumford, 2006). These methods are intended to ensure that both technical and organisational aspects of a system are considered in the design with an intended result to better understand how human, social and organisational factors affect ways that work is done and technical systems are used (Baxter & Sommerville, 2011). The sociotechnical perspective promises that system design is a process that carefully integrates both social and technical factors that influence functionality and usage of computer-based systems, Baxter and Sommerville have argued. This approach creates a culture that leads to design competence leading to organisational learning and effective change management (Mumford, 1983). In the end, it is assumed that the system will meet the

expectation of the organisation for which it has been developed. According to Braxter and Sommerville (2011), there is evidence that adopting the sociotechnical systems approach to systems development leads to systems that are more acceptable to end users and deliver value to stakeholders.

In addition to system acceptance and meeting other organisational requirements, the participatory approach unleashes the democratic processes that enable users to control their work environments and future changes that may be necessary (Mumford, 1983; Spinuzzi, 2005). Through participation, employees are able to increasingly build interest and cohesion in handing challenging work. The participatory approach would, therefore, appear to be the more suitable way to design technical systems as long as managers and specialists agree to meeting both human needs as well as technical and business needs (Mumford, 1983). The design process should meet the needs of the users, but it requires that the users understand these needs, set specific user goals and have the knowledge of the organisation design that can contribute to achievement of human goals, Mumford has argued.

4.3.2. SOCIOCULTURAL PERSPECTIVE

The research process was designed and developed based on activity theory and expansive learning. In dealing with activities and tasks in the research process, activity theoretical framework was adopted to show the link (Lim, 2002) to and between sociocultural and sociotechnical perspectives. The research project therefore was implemented following activity theory and expansive learning as developed by the Finnish psychologist and workplace researcher Engeström (1987, 2000, 2001) whose work is the basis of the framework for this thesis. The activity theory originated from the cultural historical psychologist Vygotsky in the 1920s and was further developed by Leont'ev in 1980s (Engeström, 2001).

Activity theory has, since the 1980s, been used in many instances to analyse successes, failures and contradictions in complex situations (Lim, 2002), such as in situations examined in health (Engeström, 2001), learning, behaviour (Engeström & Sannino, 2010) and work studies (Engeström, 2000), to understand and resolve issues. Activity theory offers a dynamic and developmental perspective on transformation and change, a dynamic model/typology for discussing changes and a relational concept of technology. The theory offers conceptual tools that are applicable to many situations to understand the activity (Lim, 2002). With its further development into expansive learning (Engeström, 2001), it is well suited to provide insights into organisation's change processes.

In formulating the sociocultural approach to cognition, Vygotsky claimed that mental functionating and human actions are mediated by tools (technical) or signs (psychological), so that cognition is not studied in isolation without the aid of a variety

of tools and people who help the learners in a sociocultural setting (Lim, 2002, p. 413). Activity theory provides us with a platform to analyse activities relating to social conditions and resolve contradictions, thereby creating new artefacts and new forms of life (Sannino, Daniels, & Gutierrez, 2009). It presents current societal problems, thus establishing the basis for collective debates about solutions. Activity theory potentially offers people the opportunity to have control over their artefacts and, thus, the future of how they will be used to solve problems.

Activity theory will therefore form the theoretical framework for analysis and interpretation of the empirical work in this research. The theory can be used at the meso-level, and the focus on activity systems provides a very productive perspective for understanding different objectives within an organisation. As such, this fits very well with the socio-technical and socio-cultural concept of infrastructure, and it provides me with a framework to analyse and interpret the results of the empirical study. The theoretical approach for analysing work and technology is based on the cultural-historical activity theory. Initiated in 1920s and 1930s by the Russian psychologist Vygotsky and further developed by Leont'ev and Engeström (Engeström 2000), activity theory has been used in understanding the interventions in the study of work and technology.

4.3.3. ACTIVITY THEORY AND EXPANSIVE LEARNING

Activity theory is a practice-based theory upon which actions bridge theory and practice (Sannino et al., 2009). It is commonly known for its six interrelated elements, represented in a triangular diagram, allowing for multiple descriptions and interpretations of dynamic situations (Zahedi, Tessier, & Hawey, 2017), such as in higher education. It is an object-driven activity in which objects are clearly distinguished from tools and vice versa. It makes conceptualization of each action simpler and more easily convincing to stakeholders who are in most cases concentrating on divisions of work and outputs. In the theory, objects are concerns that are generators and foci of attention, effort, motivation and meaning. However, people through their routine activities continually change, and these changes lead to the creation of new objects, which are a consequence of intertwined multiple activities.

Engeström (2001) presents three generations of activity theory with Vygotsky's idea of mediation, where a complex mediated act is defined by the subject, object and the mediating artefact in a simple triangle. The analysis based on this generation was basically an individually based activity with known stimulus (S) and response (R).

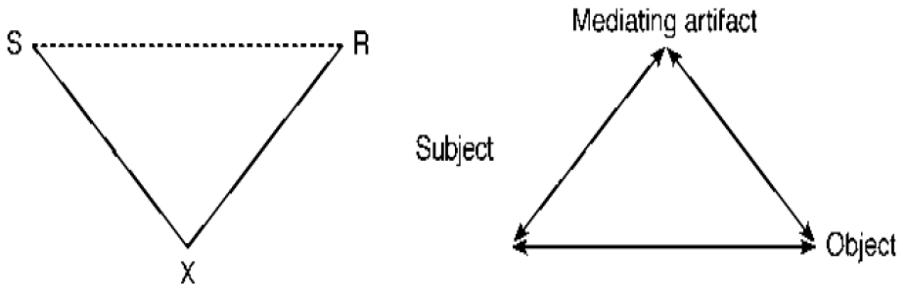

Figure 4-1: (A) Vygotsky's model of a mediated act and (B) its common reformulation. (Engeström, 2001, p. 134).

The third generation is a modification of the second generation based on Leont'ev who worked on differentiating between action and activity (Bakhurst, 2009). The second generation developed conceptual tools to understand dialogue, multiple perspectives and networks of interacting activity systems by expanding the analysis upwards, downwards, inwards and outwards (Engeström 2001).

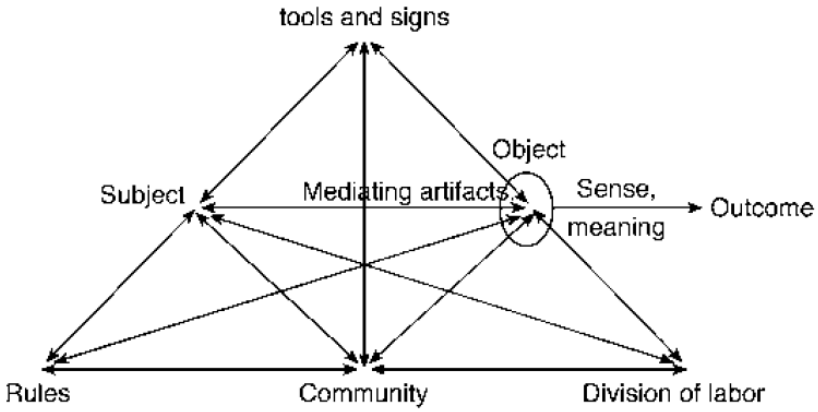

Figure 4-2: The structure of a human activity system (Engeström, 2001, p. 135).

Activity theory seeks to carefully examine developments within practical social activities and those that transfer social conditions, resolve contradictions, generate new artefacts and create new forms of life (Sannino, 2011). As a result, the framework establishes smart connections between theory and current educational challenges, and it links to propositions for future actions and activities. Its strength is therefore that it provides the conceptual and methodological potential for studies that help humans gain control of their own artefacts and, thus, determine their future (Engeström, 1999)

by shaping technologies. Such technologies that are in the workplace today are strongly aligned to the ICTs.

In his description of developmental work, Engeström (2000) indicated that historically evolving inner contradictions are the basis of movement and change of activity systems. Contradictions are vital in stimulating change and transformation in situations where change is advocated for. According to Engeström, many professional practices are advocating for multicollinearity in their work. The boundaries of traditional work organisations are therefore collapsing along with the research conceptual frameworks upon which they were formed. As a result, he also noted, 'new concepts such as learning organisations, knowledge management and asocial capital' have emerged as hybrids from other disciplines (p. 960). He further posited that this emergence has allowed for researches to consider institutions and communities as units of analysis rather than individuals. Engeström (2000) has also introduced the cultural-historical activity theory (CHAT) as a theoretical framework that attempts to overcome challenges by bridging between micro and macro, mental and material, qualitative and quantitative, and observation and intervention research (Engeström, 2000), thus responding to issues at the meso-level.

The second generation of activity theory had a weakness in its failure to address issues of cultural diversity through cross-cultural research (Engeström, 2001). Thus, the third generation of the activity theory was designed to handle the issues of dialogue amongst different traditions and perspectives (Engeström, 2001). A basic model of the third generation of activity theory, based on the developments of Engeström, is shown in Figure 4-3. It depicts two interacting systems creating outcomes that are resultant objects for another activity, thus showing how it can be expanded.

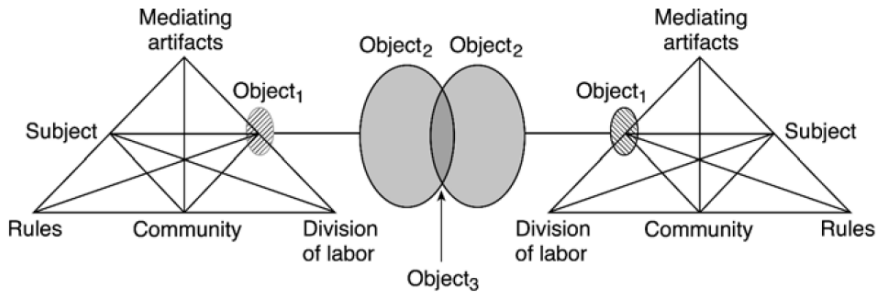

Figure 4-3: Two interacting activity systems as a minimal model for a 3rd generation (Engeström, 2001, p. 136).

Thus, expansive learning is a new type of learning which emerges as practitioners struggle through developmental transformations in their activity systems while moving across collective zones of proximal development (ZPD). This process provides a springboard for a didactical method to ascend from abstract to concrete and enter into the cycles of expansive learning. The springboard is used here to mean the

opportunity to use expansive learning as an analytical tool for understanding and explaining our research outcome. Engeström further developed the ZPD with the addition of societal perspectives. It is upon this that the study of infrastructure for learning can be understood through the theoretical framework of expansive learning.

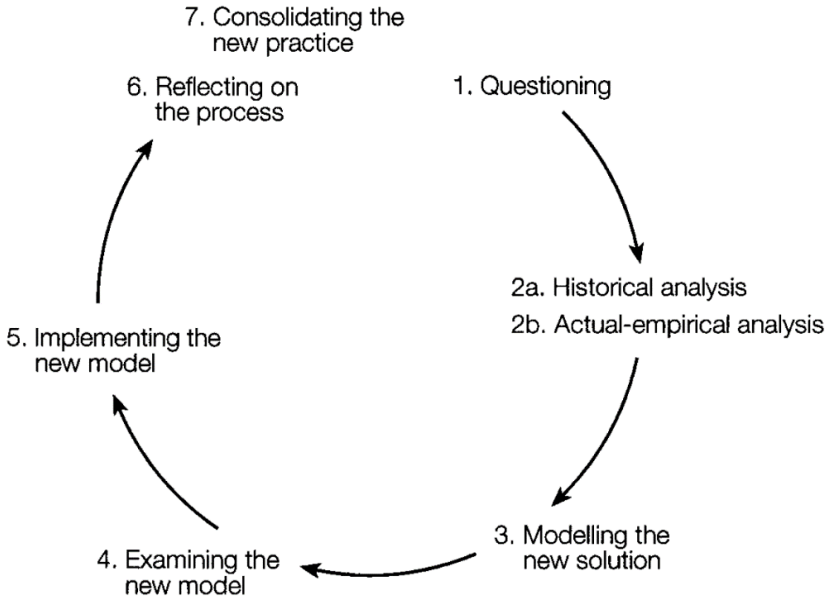

Figure 4-4: Expansive cycle of learning actions (Engeström, 2000 p.970).

Expansive learning is a complex historical process involving the transformation of the institutionalised form of practice (Virkkunen, 2009). Expansive transformation of an activity system may comprise several smaller cycles of expansive learning through which partial solutions are created. Thus, expansive learning is a theory aimed at expanding and guiding the collective transformation efforts in organizations as well as workplaces. Accordingly, learning is embedded in the transformations in activity systems and that the driving force does not come from pre-set ideas but from the need or contradictions in the present activity. The process of expansive learning is therefore understood as the creation and resolution of successfully evolving contradictions in the activity system (Engeström, 1999). Contradictions stimulate and provide the springboard for the need for change and transformation in the activity system. The change in the activity system then leads to the discovery of an experimental laboratory called the change laboratory.

CHAPTER 5. METHODOLOGICAL APPROACH

Infrastructure has been studied and used for many years with most of the scholarly studies being done on the physical, for example, material infrastructure, which is referred to by its functions, as in communication, telecommunication, housing, transport, computing hardware and IT. However, this concept has received less research attention from the social and cultural perspectives related to the humanities.

The twenty-first century is seeing the rival of the sociotechnical approaches such as sociotechnical systems design (Baxter & Sommerville, 2011) and sociocultural approaches such as the CHAT (Engeström, 2000) for analysing and redesigning work. Sociotechnical approaches normally contribute to the problem-solving scenarios related to the workplace and aims at providing a democratic platform for both designer and users (Mumford, 2006). This approach is driven by pragmatic ideas. However, the sociocultural approaches are aligned to the transformative paradigm because of its agenda to contribute to change. The sociocultural approach provides a very strong theoretical method for analysis through the CHAT where the triangular models are very useful for identifying different stakeholders and their positions on the activity system. Technology as a mediation tool is strategically built into the theory, and the idea of expansive learning, the dynamism focusing on the tensions and contradictions align the application of the sociocultural approach with research despite its alignment to the transformative paradigm. Both approaches suitably use participatory design methodology appropriately in strengthening user contribution to the development and use of technology, although there are slight differences in how the methodology is applied in research.

These approaches are presented in areas such as participatory design methods which are key to the sociotechnical systems design where end users are involved during the design process. Participatory design covers a whole range of methods and often involves users or user representatives, effectively including them in system design and development during the project (Baxter & Sommerville, 2011). Based on the fact that every project is unique, designers must make informed decisions on which design approaches, methods and techniques to use (Sanders, Brandt, & Binder, 2010). Therefore, based on the development research (Zander et al., 2007), sociotechnical and sociocultural approaches, in relation to technology concepts, make the participatory design (PD) approach the most appropriate for this research project.

5.1. PARTICIPATORY DESIGN METHODOLOGY

PD, which originated in Scandinavia between the 70s and 80s, was influenced by Marxist concepts of the commitment to empower workers and espouse democracy at the workplace (Spinuzzi, 2005) and to increase user involvement in design of the workplace (Mumford, 2006). PD has had an impact by strengthening users' skills and product quality. It has emerged as a design practice that involves non-designers in various co-design activities throughout the design process (Sanders et al., 2010). User participation in the decision-making process on what affects their life at work is taken very seriously (Mumford, 1983; Spinuzzi, 2005). In this study of infrastructures for learning, the design process is based on user perceptions of the technology and how it can augment their work of teaching. It is historically a Scandinavian tradition to involve users in the decision-making about what will affect workers using technology in the design process (Spinuzzi, 2005).

PD has been defined as set of theories, practices and studies relating to end users as participants in activities leading to computer technology products (Spinuzzi, 2005). This methodology is important when users need to be empowered in developing, strengthening and sustaining collaborations between users and designers. It attempts to actively engage users and designers in the product design process to ensure that the quality of the product meets the expectations of all stakeholders (Bødker & Iversen, 2002). More emphasis is placed on the process and procedure of design, as opposed to the product perfection. From the 80s onward, PD has developed as a method contextual inquiry (Sanders et al., 2010). The methodology precisely blends practical intervention and theoretical reflections leading to higher acceptance of outcomes (Spinuzzi, 2005). In Uganda, this is a new approach in computer system design where users play a critical role in defining their needed design or product and are active participants/designers throughout the process.

PD has a rich history in incorporating disadvantaged groups in society into research, which has made it widely used in development research fields relating to the design of ICT systems (Zander et al., 2007). It involves people actively participating in a research process relating to technologies in workplaces, communities and social institutions (Simmonen, 2014) such as higher education. According to Sanders et al. (2010), these people, also then called co-designers, are from 'different backgrounds, experiences, interests and roles within the project'(p.1) making it difficult to suitably engage them in activities.

Early researchers conducted work to open up the design of ICT systems to participation of users, and currently PD presently spans a wide range of domains and makes use of a broad repertoire of tools and techniques in work- and community-oriented research (Sanders et al., 2010). As a way to involve people in the design of technology, PD thrives on collaborative processes determined by participation of stakeholders who use that technology (Simmonen, 2014).

Methods, tools and techniques have been developed to support users and designers and help them to reflect on future practices that new technologies might bring through PD, whose literature is increasingly including technology use and reconfiguration to support new and anticipated use (Simmonen, 2014). It is important to note that these tools are designed for specific user groups to develop representations of systems and products, while other research has provided toolkits for supporting users in tailoring and appropriating technology (Sanders et al., 2010).

The PD approach has been more about design with the aim of producing artefacts, systems, work organisation and practical knowledge than about the research itself (Spinuzzi, 2005), and so the design process in PD is in itself described as research. The methods that are drawn from the approach are many. For example, based on the Scandinavian PD, we see methods such as the Future Workshops (Apel, 2004; Sannino et al., 2009), interactive storyboard prototyping, PICTIVE (Sanders et al., 2010; Spinuzzi, 2005), Co-Design Workshops (Sanders et al., 2010) and others like the Focused Group Interviews. However, according to Spinuzzi (2005), PD encompasses methods that are also used in the construction of emerging design: 'All these methods are used to iteratively construct the emerging design, which itself simultaneously constitutes and elicits the research results as co-interpreted by designer-researcher and participants who will use the design' (p. 164).

The methods ensure that participants' views and interpretation are considered in the research with the goal to concurrently envisaging and shaping it in ways described by user requirements (Spinuzzi, 2005). According to Spinuzzi, PD is distinguished from other related approaches in that all the work is done with the users, other than on behalf of the user as expressed in user-centred design, for instance.

Sociotechnical and sociocultural perspectives to design infrastructure would require that all stakeholders democratically have the opportunity to express themselves in the workplace and in the design of an artefact, technology or a system they will use in their work. The PD methodology was chosen for this study as appropriate in achieving the goals of this research where many actors with unique backgrounds and interests were involved. This methodology is influenced by the action research tradition of attempting to change situations (Mumford, 2006). To make this change practically happen, stakeholders' approval and involvement is important. Using such methodology as PD, user participation is strengthened, and product acceptance and use are increased (Mumford, 1983). The approach has been used in understanding human-centred computer interaction, computer collaborative work and, generally, technology-supported learning for a long time (Spinuzzi, 2005). It is then appropriate to apply it in a study where technology appropriation is proposed by the users based on their knowledge and motivation to introduce new ways of teaching and learning. Specifically, in this case, user centeredness in the design of infrastructure and how technology should be organised around the teaching and learning processes was seen as relevant. We followed Bannon and Ehn (2012) in that, other than focusing on the

technology design, we focused on how technology was introduced and used in the organisation.

A simple model of how stakeholders are organised around the activity of design is illustrated in Figure 5-1. It is a relationship model that can be used to manage the requirement elicitation during the design process. Its ultimate use is to share and learn to relate all the requirements of the user's needs that can be afforded by the available technology. The idea is not to design for an artefact production but to integrate these artefacts and other technologies to enhance work. The design is a description of the process of reorganising the workplace for better service delivery.

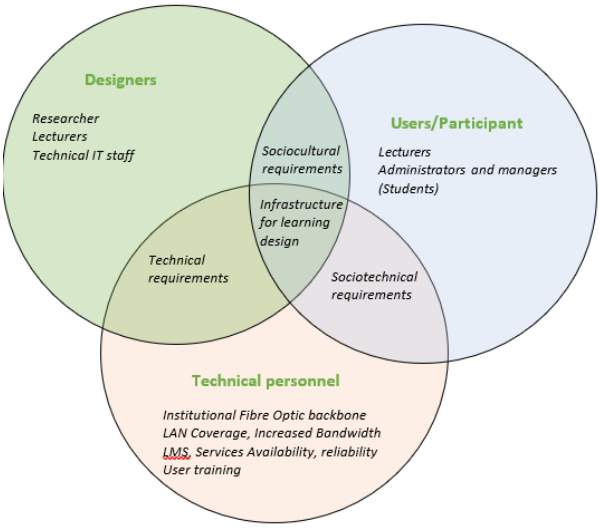

Figure 5-1: Relationships amongst designers, users and technical personnel in the design process.

5.1.1. DESIGN IN PARTICIPATORY DESIGN

The term *design* is an English word and as a basis for research has many meanings. The interpretation of the term depends on the background of the individual or groups where it is being applied. According to Bannon and Ehn (2012), the term came from the Latin word *signum*, meaning sign, implying to designate or appoint. The meaning gradually shifted to mean-making and then later to drawing or sketching. It is both a noun and a verb which can refer to a process or a product. It is viewed as a craft relating to creativity and production or a field of study based on humanistic historical tradition and a rationalistic, scientific approach (Bannon & Ehn, 2012). Design may be studied in relation to the planned organisation development process. The involvement of users in the design process was pioneered by PD research and has been

mainstreamed to activities such as user-centred design and user-driven innovation, as well as others like user-experience design (Bannon & Ehn, 2012). This study uses the term in relation to what Bannon and Ehn have called the 'how' of designing, with a focus on the practice of design which involves people and the need to respect different voices and to engage modes other than technical and current evaluation through the design process.

5.2. METHODS AND TECHNIQUES

PD affords several methods and techniques that are applicable to studies relating to both sociotechnical and sociocultural perspectives. The choice of a method or groups of methods depends entirely on the nature of the research problem under investigation. The methods are usually employed in iteratively constructing a promising design which becomes the outcome as understood by both researchers and participants or users who will own the resulting design either as a product or a service. Different methods lead to delivering designs as artefacts, work flows and work arrangements (Spinuzzi, 2005). The research methods chosen here were intended to provide the necessary steps to support a research undertaking.

In this research, the researcher adopted Future Workshops (FW), Collaborative eLearning Design (CoED) Workshops, Focused Group Interviews and document review/observation as appropriate methods for data collection. Aligning with the Scandinavian PD, these methods followed the provisions for a user participation that advocate for democratic control and deep involvement in decision-making. These workshops were planned as part of the larger project and advertised for participants to express interest. This means that participation was voluntary, and that willing people were motivated to contribute to the change process applied. Data were collected from workshops and baseline studies and through reading institutional documents relating to developments in ICT and infrastructure design and use in the institution. Based on the workshops which were by their nature conversations about topical areas of concern, the research followed the qualitative research approach. Also, based on the nature and diversity of stakeholders involved in the design workshops, some of the outcomes were based on the paper prototypes and data flow diagrams. This was strengthened by the broad application of PD (Spinuzzi, 2005). The use of Future Workshops (Jungk & Mullert, 1987) and CHAT facilitated the combination of design and implementation of infrastructures for learning by merging the voices of participants (Sannino, 2011) in the intervention.

In the subsequent section, I describe in detail each of the methods and techniques that are used in this study. However, I first show a simple outline of these methods with a short description of their purpose in this study, responding to the 'why', 'what' and 'who' of the process.

Table 5-1: Summary of methods used in this study.

Method	**Why**	**What**	**Who**
Baseline studies (interviews, documents and surveys) Four universities participated	To understand the current trends and stakeholders that will participate Describe the state of infrastructure for learning in higher education	ICT infrastructure planning and design Alignment of implementation to the institution core function of teaching and learning Available technologies and supporting policies for implementation	ICT support staff, planning department and user departments
Future Workshop (FW)	Understand the social and historical perspectives Underscore the need for change and future activities	Participation in understanding the past and present and shaping future work through democratic means	Teachers, administrators and ICT support staff
Design Workshop	Engage with stakeholders in a co-design workshop environment to define and design for future interventions Determine some design principles Produce a prototype	Co-design activities based on the needs identified by FW Prototyping with the users and evaluating these prototypes against requirements	Teachers, administrators and ICT staff

Focused Group Interviews	Revisit design principles and compare them with prototypes New iterations	Evaluation of the running prototypes, revisiting the challenges, design issues, new requirements and technologies Revisiting the adoption of sociocultural and sociotechnical perspectives in the design	Purposively sampled administrators, ICT support and user communities
Document Reviews	Understand the current and historical processes of designing and implementing infrastructure for learning at the university	Reviewing current and planned institutional structures, policies and IT personnel	ICT staff, administration and success stories from other institutions from the region

5.2.1. THE STUDY INTERVENTION

This research followed a simplified model to determine how the different methods were used and how they were connected. The PD methods chosen were all based on workshops that were done to fulfil the BSU implementation strategy. These were the same workshops from which data for this study were obtained with an emphasis on the technology and human praxis. In this design, we followed a sociotechnical approach based on predetermined order of the workshops to some degree; however, the activities were in line with the sociocultural perspective.

From each of the workshops, I related the discussions to infrastructure design and related the design principles to the knowledge of resource-limited settings. Key contradictions and design choices provided starting points for the next workshop based on how these contradictions were resolved in the prior session. Reflection sessions at the beginning of the workshops were useful in gauging whether those

contradictions were settled, or if new ideas had emerged thereafter. This way active participation and collaboration in the workshops were maintained.

The steps that were used in the study interventions followed a logical flow:

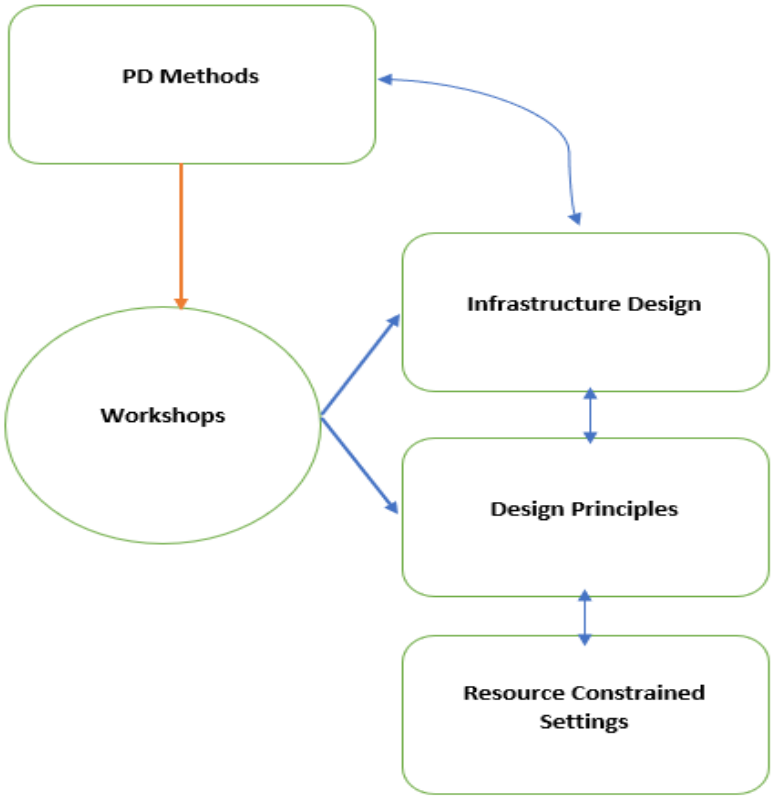

Figure 5-2: Model describing the organisation of the workshops in relation to the study object.

The methods determined how the workshops were organised around the development of infrastructure that was relevant for this research project.

5.3. ETHICAL ISSUES IN THE STUDY

Qualitative research by its nature involves collecting data from people by engaging them in them research (Bjorner, 2016). This underscores the importance of ethical considerations at all stages of the research in resolving issues that arise along the research continuum. For each of the sessions, consent forms were used to

communicate the research intention, and consent was sought from each participant at the beginning. The data were stored on computer systems with access restricted to only the team involved in the research. After a period of five years, the system will be cleaned, and where there are computer problems, hard drives will be removed and stored separately by the research team. Although the research targeted a single faculty, participation where data (audio and video) were being collected was voluntary. The Danish code of conduct in research was followed, and we are also aware of the new EU standards on data protection, which we carefully observed as part of addressing data protection.

5.4. METHODS AND DATA COLLECTION

This section presents a description of the methods that were used for data collection.

5.4.1. THE FUTURE WORKSHOP

This method was developed in the 1970s as a tool for the civil action groups striving for better enforcement of their future interest (Apel, 2004). The Future Workshop (FW) method is based on 'social learning', and it is praised by constructivists in educational sciences as individual participants are able to find new resolutions in their reconstruction of reality (Apel, 2004). In order to transform a system or a process, it is important to critique the actual situation, dream about a preferred future and then find ways to move from the current to the desired future situation (Vidal, 2005). This underscores Hegel's dialectics where problems are solved by critique (Apel, 2004) and that critiques expose the present circumstances. This method emphasises learning, teamwork, democracy, assessment and participant empowerment, making it a good method that delivers processes leading to a better society (Apel, 2004; Vidal, 2005). FWs are, therefore, used to facilitate participation in group processes dealing with real-world problems (Vidal, 2005), for example, creating better future work environments, tools and policies. The method seeks to support creativity and the creation of group synergies for individuals who are in the same situation.

The method has been applied in many different settings and in handling unique situations, especially in Scandinavian communities (Vidal, 2005), and it has gained a solid place in management theories (Apel, 2004). This technique, where participants share knowledge and experiences in a more productive way, has been commonly used (Apel, 2004) for research. Vidal attempted to give both a practical and a theoretical insight into the method. With the increase in the popularity of the method, the need to prepare a concise guide for facilitating FWs soon arose (Lauttamäki, 2014). FWs, according to Jungk and Mullert (1987), are organised in phases, which Apel (2004) outlined as preparation, critique, fantasy and implementation and which were summarised by Vidal (2005). The Finland Futures Research Centre has presented a format that can be used when seeking answers to practical questions and devising plans for achieving desired future goals (Lauttamäki, 2014). This is a very effective

way of involving users in innovatively solving common problems, such as designing infrastructure for teaching and learning in higher education. To prepare teachers to design for the future of integrating technology in teaching and learning, the FW provides an excellent alternative and environment.

The workshop tasks encompassed principles of creative and or collaborative problem-solving and socially allowed the groups to express themselves as a way of facilitating responsible participatory democracy (Lauttamäki, 2014; Vidal, 2005).

5.4.2. COLLABORATIVE E-LEARNING DESIGN WORKSHOP

The Collaborative E-Learning Design Method (CoED) provides guidelines on how to conduct design workshops on the design of courses, course modules and other educational activities (Ryberg, Buus, & Nyvang, 2015). By providing the guidelines and an environment for practitioners to play a central role in the design process, it is well-suited to the PD approach (Ryberg et al., 2015). In this instance, CoED reinforced the FW that elaborated on many aspects of the need to design university programmes to adopt the PBL and blended learning. However, the strength of this method lies in its provision for negotiation and collaboration on establishing a shared vision amongst practitioners (Ryberg et al., 2015).

This method is supported by a web-based system that generates alternatives for the practitioners to use in the planning and negotiating or collaborating for a shared goal. These resources mediate in the design process by identifying required resources and tools that are useful in arriving at a shared design idea by the practitioners. It however does not support practitioners in generating formalised descriptions or levels of detail in the design (Ryberg et al., 2015).

This method facilitates the design process through five principles and runs through three phases (Ryberg et al., 2015). These are listed by Ryberg et al. as:

1. Facilitates conversation about eLearning design
2. Structures conversation about e-Learning design
3. Produces design specifications and/or actual design rapidly
4. Involves eLearning experts, domain specialists and future users of the eLearning design
5. Involves at least two people in the design process.

These are guidelines for the CoED method that support structured dialogues and design activities amongst diverse groups (Ryberg et al., 2015), such as the participants in this study's workshop. In the same workshop, facilitators from Maseno University eCampus formed part of the team. I treated these Maseno team members as experts and domain specialists. This method allowed for involvement of learning experts,

domain specialists and future users of the learning design (Ryberg et al., 2015) making it very appropriate for this research.

The three phases of the CoED method according to Ryberg et al. are:

1. Focus the eLearning design process (presentation)
2. Identify overarching values and design principles (card sorting and selection through prioritisation)
3. Specify design (card sorting and design).

Participants were drawn from the university teaching, technical and management staff. Inspired by constructivist theory, the workshop participants were purposively divided into groups. This division furthered the discussions and provided an in-depth analysis of the current and future curriculum and infrastructure design issues.

This workshop was organised around the theme of designing a new curriculum and infrastructure that could support it. Staff participants designed, agreed on and set the basis of integration of ICT to facilitate collaboration, teaching and learning. A global list of requirements, based on the literature, was generated using the CoED application at the centre for user driven innovation and design at Aalborg university.

5.4.3. FOCUSED GROUP DISCUSSION

This method provides another way to collect data through interacting with participants who are purposively selected to discuss some specific themes. It is a type of interview, but rather than the participants interacting with the interviewer, the interactions are amongst the participants themselves (Coto, 2010). In such sessions, participants are free to give opinions on the subject matter, but also through listening to other colleague's opinion, theirs are also shaped in the engagement process. The method provides for up to eight participants per group (Creswell, 2003) or a maximum of ten (Gibbs, 1997) which might depend solely on the topic of interest.

This method is applied in situations where there is need for various perspectives about the topic or to explore ways to resolve contradictions about a topic and allow the participants to re-examine and consider their understanding about a particular topic (Gibbs, 1997). It is also used in triangulating research data with other methods like observation (Coto, 2010).

Along with various applications and strengths of the method, there are some weaknesses in the method, such as intimidation of the experienced participants, individuals dominating discussions, researchers having minimal control of the data that are produced and the lack of a competent moderator who can counter some of these challenges of the method (Coto, 2010).

The aim of the Focus Group was to understand stakeholder perceptions of the sociocultural and sociotechnical perspectives of the infrastructure for learning prototypes implemented at the university. Moreover, it was intended as a way to learn how the infrastructure would support the new ways of teaching and learning at the university, based on the redesigned curriculum for the Master of Education and also the tests for the Master of Business Administration. It was also considered as a means to review the operationalisation of the policies regarding eLearning/ blended learning based on the same programmes.

This method was used based on the design-use-implementation of the proposed IT infrastructure. The point of departure was the fact that infrastructures are built to meet human and institutional goals. These goals were described in the FW and the Co-design Workshops, and interventions leading to prototypes were recommended.

Based on the FW and design workshops and the implementation of a prototype, participants were purposively selected to participate in this workshop. These participants were people who had been involved throughout in the design and redesign of the curriculum for PBL and infrastructure for learning which integrated ICT based on the university's strategic plan. This workshop covered four themes (sociotechnical, sociocultural, user, management and planning) of infrastructure for learning at the university.

5.4.4. SELECTION CRITERIA

The participants were selected based on responses to the advertisement that was posted by the project. The participants voluntarily applied to participate and were selected on a first come, first served basis. However, for this research, specific categories of participants were purposively selected. These categories included the IT staff and teachers who were redesigning the master programme in education. The academic staff in the Master of Education Planning, Management and Administration who were responsible for the curriculum design and delivery formed the core. In addition to these staff, we had the technical staff in the IT and university management. This latter category was targeted because the study of infrastructure requires funding and maintenance of these ICT systems for sustainability.

This was purely a qualitative study. Sampling depended on the enrolment of these academic and support staff. Attendance in cases where data were collected ranged from 30 to 40 participants, although in a few cases, there were more. The universities were purposively selected to give an overview of infrastructure for learning and to compare the steps being taken to integrate ICT in the core functions of the university. The emphasis of the survey was on the state of ICT infrastructure and how it was understood in relation to sociocultural and sociotechnical perspectives. Documents reviewed were purely selected based on the need to understand organisation structures for the ICT unit, ICT and other policies relating to the use of IT at the university.

5.4.5. DATA COLLECTION

The sources of data for this research were diverse and complicated since this project was part of a larger capacity building project, so the researcher had no control of its implementation activities. The data collection techniques included baseline survey, FW, Design Workshops (CoED), Focused Group Interview and document analysis. The target group for the study was the academic and IT staff at Gulu University. The participants were drawn from the staff who were participating in the workshops organised through the project. In this study, the researcher selected workshops that were organised around the thematic areas of technology-enhanced learning and pedagogy as data sources for the research.

Empirical material was drawn from these workshops as field notes, audio recording transcripts, workshop reports and paper prototypes that were generated during the workshops. Some primary data were collected from a survey of four public and private universities across Uganda. Further, data were collected from the document reviews from Gulu University's IT services/unit. However, the baseline study was done to inform this study about the status of ICT infrastructure for learning at these universities in order to build a case for Gulu University. It also described how these universities managed to achieve their targets or failed to do so in integrating technology in their core activities.

The data collection process was organised as shown in Figure 5-3.

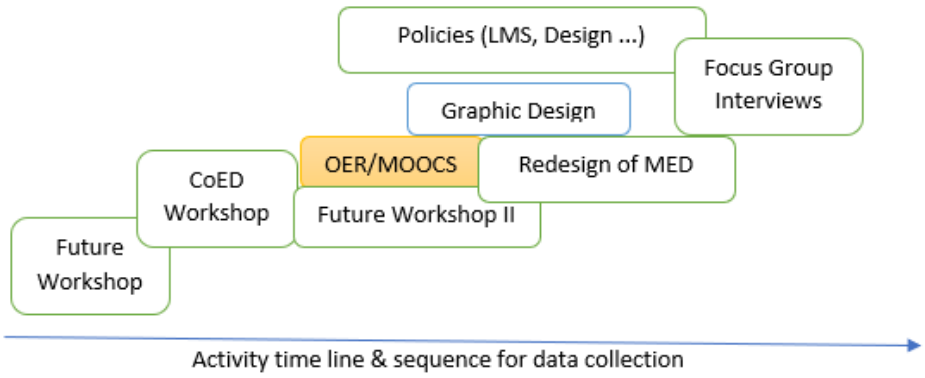

Figure 5-3: Data collection process.

Data was collected through FWs with the teachers in the department and other staff who were also teachers in the programme. This was followed by design workshops, CoED and graphic design of the learning management system based on decisions from the CoED and user requirements. A design workshop was conducted from which other requirements, such as policies, bandwidth and technical personnel, were identified as

elements in infrastructure for learning. In this workshop, participants explored the use of Massive Open Online Courses (MOOCs) and Open Education Resources (OERs) as alternatives for supporting the library resources and staff in understanding the diversity of available learning resources internationally. A focused group discussion after the prototype was in use for at least a year was about how the infrastructure was being used, and the perspectives from stakeholders on its affordances to teaching and learning were solicited. The IT staff helped in writing a narrative of the position on IT infrastructure in which other infrastructure requirements were identified and presented. I will discuss these further in subsequent sections of this chapter.

5.4.6. BASELINE STUDY

Ugandan universities were purposively selected to ground the research on what had been achieved in other higher education institutions and the trends in designing infrastructure for learning. A semi-structured interview with a few defined questions led to informative conversations (O'Leary, 2004) following on the interviewee experiences. The interview was also designed for both technical and non-technical staff who were either teachers or support personnel as these institutions are semi-autonomous and define their own path depending on the management priorities for the set goals.

5.4.7. RESEARCH JOURNEY AND DATA COLLECTION ACTIVITIES

The project's empirical work was based on interactive workshops that had been running as part of the overall capacity building project workshops. The themes of the workshops that were related to the project are presented in the summary in Table 5-2.

Table 5-2: Summary of the research journey and data collection activities.

	Workshops			
Date/month	**Method**	**Objective**	**Participants**	**Data**
August 2015	Future Workshop I	Design for learning in practice workshop to explore the current and prospective practices of educators as designers	40 participants: Academic staff and support staff, administrators	Audio, visual and reports, flipcharts, transcripts, presentation slides

August 2015	CoED Workshop I	Building on the pedagogical, ICT and subject specific experiences of the educators and seeking to establish a mutual framework for the design for learning in practice	40 participants: Teachers, administrators	Audio, visual and reports, flipcharts, transcripts
February 2016	Future Workshop II	Redesign of master's in education planning management and administration integrating PBL and ICT	36 participants: Teachers, university managers	Photos, field notes and transcription of FW Video recording of two groups (technical quality was poor) Video recordings of plenary sessions
March 2016	CoED Workshop II	How curriculum could be designed to adopt new ways of learning Infrastructure requirements for the new pedagogical approach	36 participants: Teachers, administrators, ICT support personnel	Paper prototypes, Field notes and transcripts Video recordings Workshop report Audio recordings

May 2018	Focus Group Interviews	Understand how sociocultural and sociotechnical issues are addressed in the design of infrastructure for learning.	10 participants: Teachers, ICT support, administrators	Audio recordings Photos Field notes Transcriptions PowerPoint slides Draft documents
May 2018	Baseline studies (survey and interview) of status of eLearning in selected universities	To understand status and how infrastructures for learning are designed in other universities	Four interviews with heads of IT and eLearning or distance education departments	Field notes Audio file transcription

FWs and CoED workshops were organised as part of the BSU II project by my colleagues from Denmark and Gulu University. The project implementation plan determined when the workshops would take place. The participants for the two workshops were solicited through the project. As I indicated earlier, the themes of the project were generally related to strengthening electronic research infrastructure and competence in BSU II. Data from the workshops has been used to support my research project.

The perspective adapted in the analysis has been to focus on ICT as infrastructure for learning, and transformation of teaching and learning, especially PBL. Electronic infrastructure at the university at the time was in its initial stages of development. Thus, this process lacked proper procedure and documentation in relation to meeting the pedagogical needs, even in the case of the existing traditional curriculum. As a result, this project provided a unique opportunity for researching the issues of designing infrastructures for learning that could support an innovative pedagogical approach.

CHAPTER 6. DATA PRESENTATION AND ANALYSIS

In this chapter, I will systematically present the empirical work done in the research project followed by detailed data description and analysis.

6.1. BASELINE STUDY IN SELECTED UGANDAN UNIVERSITIES

I conducted a semi-structured interview with staff in the IT, eLearning and, in one case, the distance learning departments in selected public and private universities in Uganda. Further, research papers from the universities on implementation were collected and integrated in the analysis. The selection criterion was purposive because I wanted to understand how different universities dealt with designing infrastructures for learning and how the up and coming universities with situations similar to that of Gulu are designing their infrastructures for learning. The emphasis of the study was based on design of ICT infrastructure for learning. This infrastructure in the survey included IT policies, IT infrastructure, library and technical staff at these universities responsible for organising and managing such infrastructure and services. The universities that formed part of the survey were Muni, Makerere, Busitema and Uganda Christian University (UCU), respectively. The institutions selected for the study represent a blend of old and new public and private for-profit institutions. The general purpose was to learn how they approached the design of infrastructure for learning and lessons from such a perspective. Makerere is the oldest of these institutions, established in 1922. It has gone through a multitude of systems intended for infrastructure for learning, more specifically for eLearning (Ssekakubo et al., 2011). UCU is a private university with relatively good infrastructure for learning, compared with government institutions. Muni and Busitema are new government established institutions, similar to Gulu and Kyambogo Universities, that opened in 2002. This selection was done to gain diverse design perspectives and experiences in order to a create a design that could be adopted at Gulu University. Table 6-1 is the summary of the data collection techniques and the type of data collected.

Table 6-1: Summary of institutions and data collected.

Institutions	Data collection technique	Type of data collected
Muni University	Semi-structured interviews with the IT staff, dean of	Audio interview data with field notes

	technoscience and library staff	
Busitema University	Interviews with IT and academic staff	Audio interview data with field notes
Uganda Christian University	Interviews with IT and academic staff	Audio interview data with field notes
Makerere University	Interviews and e-mail with documents	Audio interview data and documents (open distance and eLearning policy)

6.1.1. TECHNOLOGY ENHANCED LEARNING AT UNIVERSITIES IN UGANDA

The interviews revealed that these universities were at different levels of adoption, depending on the commitment of the administration and collaboration with other universities locally and internationally. Collaborative and other capacity building projects with international partners seemed to have played a major role in initiating and creating awareness about technology-enhanced learning at these institutions. This was because most of the responses tagged eLearning initiatives to international collaborations with just one on local collaboration with Makerere University. Staff perception of technology-enhanced learning was reported as another important factor accounting for the universities' different levels of adoption. This was the same in all institutions, but most participants agreed that government had shown commitment to support ICT in all sectors and specifically in higher education.

The study showed a pattern that was more grounded on a managerial directive. Makerere University, for example, had used various IT systems designed for eLearning and finally chose Moodle (Ssekakubo et al., 2011). However, this system had yet to fulfil its potential of campus wide use. The systems had been decided upon based on management in collaboration with development partners.

An interviewee from Busitema indicated that a Commonwealth project allowed them to start the eLearning initiative. Another respondent of Muni said, '*We incorporated ICT and blended learning in our structure right from the beginning*' and '*all teachers have to use our blended learning environment'.* Muni developed a strategic plan that incorporated eLearning as one core delivery method the university would use in its teaching and learning. Although I did not ask for implementation details, the interviewee indicated that the taskforce, in setting up the university, envisioned and streamlined eLearning in their implementation plans. This could be seen as an

approach that had mixed expert and user perspectives. The establishment task force might have envisioned all these and streamlined their plans to capture these new ways of teaching and learning. It is also important to note that Muni is the newest university (founded in 2013), so it might have learnt from other institutions' mistakes and settled on having this incorporated in their structure. At UCU, the ideas were championed by the department staff from the faculty of Science and Technology and was later taken up by management. An interviewee mentioned that 'eLearning initiatives was initiated by staff'.

Table 6-2: Summaries of information based on strategies for IT infrastructure.

Interview questions	Summary of responses
Motivation or inspiration for technology-enhanced learning	Peer learning and inspirations from other universities; the need to increase coverage, support students and reduce cost; reduced paperwork; reduced staff workload; providing flexibility in delivery; collaboration with other institutions and companies
Duration of integration	Duration ranged from 1–10 years
Reasons it took this long or did not	Responses were varied and included curriculum development and accreditation process; perception of users; funding and other resources; pedagogy; management support; cost of the technology
Adoption strategies	Mixed top-down and user initiated; top management decision to adopt ICT and dedicate resources in two cases; donor initiated (e.g. Commonwealth project); department staff initiation; collaboration with other universities; award of certificates to workshop participants for motivation; adequate planning for eLearning; development of eContent; financial support; improvement of internet connection and ICT infrastructure

Programmes on eLearning currently	In some cases, all programmes were on the electronic platform; some have course units by department as pilot programmes; others are still improving their infrastructure; one did not have any official system running at the time of the interview
eLearning platform	All universities were using Moodle even it was yet to be formalised at Busitema and Gulu
Reason for platform choice	Moodle was leading; well-tested, free and supported by a community of developers; has good security and runs effectively on the university intranet; user-friendly, low initial cost, data integrity; adopted and used by other universities; readily available; provided through collaboration
Specific collaboration tools used/popular on Moodle	Chat; forums; assessment; review; integrated MOOCs; Coursera courses; voice function
Reason for these collaborative tools' popularity	Social elements of the tools such forums, voice, chat functions that are reported to reduce complications since they are interactive (student–student) and engaging for the users; at UCU, other users are reported to prefer the use of social media and email instead of these tools
Institutional changes based on introduction of technology-enhanced learning	Getting better equipment; increased bandwidth; collaboration with other universities; administrative support; computer laboratory; problem-solving made easy
Steps toward transformation of services	UCU and Muni reported reduced cost on books and paper for both students and management; timely results; ease of tracking progress; use of system

	audit trail, time management; use of eLibrary; increased interest in developing tools and reduction of plagiarism cases by the students

From the responses summarised in Table 6-2, we can see that there were various motives, resources, levels of management support and perspectives regarding the requirements to introduce eLearning at these institutions, thus impacting the design of infrastructures for learning. The universities generally seemed to derive their motivation and inspiration from the need to reach a wider audience, afford distance education (Makerere), offer flexibility of education in regard to distance students to use facilities on and off campus, engage students more in the learning, make use of available technology tools, reduce paper work, reduce staff workload and reach out to the community. A further in-depth study is necessary to organise and determine some definite pattern since currently there are none.

The universities have been undergoing the process of integrating ICT in teaching and learning with the responses showing that some institutions have taken anywhere from two to 20 years to achieve this. Muni University had already planned all this at the time of its establishment, so within two years, they were implementing the plan. However, others have been gradually improving their systems and technologies. Over the years, many of the technologies became obsolete, but new and advanced ones were being acquired. Respondents' responses indicate that some of these processes have taken a long time because of the lack of funding, negative perceptions of staff, lack of technology training and pedagogical disputes. While other institutions reported that there have been challenges with management support for ICT integration, curriculum development and accreditation, poor infrastructure (bandwidth), internet (reliability), cost of investment and user acceptance, there were external factors such as accreditation by National Council for Higher Education (NCHE), optic fibre backbone and internet stability. At Makerere University, the researcher was provided with both the IT and open distance eLearning policies that were already in use, although the implementation had only began three years earlier. Two of these institutions had their ICT policies available online. Makerere University (https://policies.mak.ac.ug/policy-category/ict-policies) and Kyambogo University's (https://kyu.ac.ug/wp-content/uploads/2019/01/Kyambogo-University-ICT-Policy-Framework_3.pdf) links to their ICT policies are currently available online. However, the other institutions, at the time of this study, had their policies governing ICT and blended learning at different formulation and approval stages.

At institutions where policies had been approved, the implementation of the blended learning programmes were in progress. In one of the participating institutions, most of the programmes are now online, and all staff deliver part of their teaching online or

at least all contents are on their LMS. Muni University claims that they have cautiously been implementing student-centred learning by adopting IT. There, the administration adopted the concept that students should bring their own devices (BYOD) as part of the requirement to join the university. It was reported to be working well thus far. However, according to the interviews, Busitema has been challenged with the lack of management support, coupled with the financial and IT resource limitations. Moreover, the university conducted a pilot eLearning programme based on an international collaboration project through the Commonwealth of Learning, but that initiative was not sustained despite the planning and content development accomplished in collaboration with Makerere University, due to financial and other resource constraints. The management at Busitema, to revive their eLearning vision, identified an academic unit that had blended learning programmes in order to spearhead the initiative. The staff are, however, continuing to develop tools in support for the blended learning programmes and developing content. The current debate concerns the workload of the academic staff. The implementation, according to one university, has increased academic staff workload. Appropriate calculations on how best to remunerate staff for the workload are being developed, but they are presently using the teacher-centred approach based on contact hours (CHs) to pay the staff.

The interview data also revealed that adoption of ICT in teaching and learning was based on diverse factors at these institutions. At Muni University, for example, top management decided at the onset to adopt technology in the delivery of education because of its geographical location, staff numbers, recruitment and other factors already stated. The management therefore allocated resources appropriately for developing eContent and eCourseware for the blended learning system on Moodle. The blended learning system was also meant to provide an opportunity for students to innovate, create and collaborate amongst themselves. Accordingly, at Muni, a department was established to oversee the process of content development, policy formulation, and collaborations with other universities researching in similar areas.

6.1.2. ANALYSIS OF THE BASELINE FINDINGS

The baseline study results indicated that Moodle is the popular, and it is the only LMS proposed or used at all these universities. The reasons are that it is known amongst academics as the leading LMS that is well-tested, open source and secure, and it can also run on intranet and is supported by an international community of developers (interviewee responses). It is considered as core infrastructure for learning in the institutions based on its functionality and history of use at older institutions. This position agrees with Ssekakubo et al.'s (2011) detailed account of five African universities' initiatives with eLearning. Other interviewees indicated that it is user-friendly, its initial cost is low compared with proprietary alternatives and that many universities in Uganda have started to use it. It is interesting to note from the interviews that most of these LMS were set up through the collaboration project except in the case of Muni. However, one respondent discouraged the use of 'free online'

alternatives such as Google Classroom. The critical issues are data integrity, security and limitations based on the system being a cloud service. The limitation indicates that the companies can only afford a certain amount of space on their servers for free access, so users are always requested to upgrade and that comes with a subscription fee. To address these challenges of integrity, security and third-party complexities, Muni hosts both their website and the Moodle-based blended learning system on their home servers.

The use of Moodle in these institutions is primarily done to support collaboration though available tools, such as discussion forums, chats, uploading of recordings (audio, video, Coursera courses, MOOCs) for students' later reflections and learning. Although respondents mentioned the use of audio recordings, including some of these available online, none of them committed to using materials from MOOCs, Coursera courses and others on their LMS. Academic staff sometimes referred students to online materials (also YouTube) for their own additional information on the subject matter. The use of social media and emails was noted as foundational to academics by some of the respondents and that such tools should be integrated into the LMS where possible. They also mentioned assessment and open distance learning (ODL) as tools that could be integrated in the learning environment. The respondents noted that students love discussion forums and chats as tools for collaboration, while instructors like facilities for uploads and revising students' uploaded work. One can see that, for staff, they tended to continue with their normal activities as described in the traditional teacher-focused approach. Despite the limited use reported, all respondents agreed that these tools for collaboration are an important part of the LMS that users need to engage with more. It was reported that these tools could be used to addresses the social needs of the users (students) or could be a form of peer pressure. The need for collaborative tools varies with users and use functions, as some users simply join because everybody (peers) has them rather than because of their actual benefits. While this may be true, the respondents could not clearly articulate the link between the use cases (reason for use) and the benefits of collaborative modules and technologies they have adopted. What was made clear from a submission of the IT staff from Muni was that these tools are being used and that the IT support could follow this from the system event logs. In respect to the administrations' concerns, Moodle provides an option for printing electronic footprints in the form of detailed event logs, so they can closely monitor progress.

In responding to how technology-enhanced learning is transforming teaching and learning in individual institutions, respondents from Muni noted that they produce timely results, they are able to do an audit trail on usage, there has been a reduction of costs to the university and to the students in procuring books and photocopying, most library services are online like at Makerere, time management has improved, students are able to review lectures and the use of the electronic library is more effective. The IT department and developers are working on customisation of some of these tools to better respond to local conditions. Results from these customisations are reported in

Makerere University's eLearning Environment (MUELE) (https://muele.mak.ac.ug/) and the blended learning environment at Muni University (https://muele.muni.ac.ug/blended/). These two systems are similar in many respects because of the pedagogical orientations. The welcome page for the Muni system says on the website that 'Technology is just a tool…. The lecturer is the most important.' which is partly true because it lacks a subjective view of technology. This, therefore, underscores the sociocultural and sociotechnical perspective of IT that informed the theoretical framework of this study.

These developments are positive strides toward adoption of technology-enhanced learning at Ugandan universities. However, the rampant cases of plagiarism amongst students have signified issues of availability of electronic resources on the internet. Students have taken to using the internet as a resource where they can copy and paste materials, especially for their coursework and research projects. Such cases require addressing through a transparent system preferably integrated on the LMS. Strong punishment of culprits is recommended. The detection of such a practice is a result of available electronic systems and other libraries that have enabled the staff to easily identify plagiarism cases as opposed to when they used paper submissions. The ability of staff to identify and report cases of plagiarism is a positive effect of the introduction of electronic systems. According one Makerere respondent, the challenge is that plagiarism software is expensive to acquire currently, but when policies are in place, this will be procured and installed. However, this is still in the planning phase.

Some of the changes brought about by the integration of ICT in learning at institutions that are using LMS were noted to be better equipment, more bandwidth procured, increased collaborations with other universities, problem-solving made easy and the university being in sync with other institutions. One example is the eLibrary at Muni which is well-structured with updated eResources relevant to academic disciplines and powered by eReaders (Kindles) that students borrow. Theses device have specific eReources controlled by a librarian to allow students access (because of subscription limitations). While Muni supports learning with these, Busitema reported the lack of computing equipment, low administration support and lack of operational computer laboratory.

Notably, some universities have done much integration in a short time (Muni), while others are yet to start major implementation (Busitema). The description of the current changes and transformation taking place in these institutions reiterates the need for better infrastructure and development of staff capacity (NCHE, 2018). There are generally improved IT services in all these institutions resulting from increased bandwidth through Research and Education Network Uganda (RENU), acquisition of hardware, software and other equipment through partnerships and projects. These are leading to timely results, eLibrary use and the reporting of plagiarism cases.

6.1.3. INFRASTRUCTURE FOR LEARNING DESIGN

Infrastructure design has diverse meanings to stakeholders based on context. The context in which the term infrastructure design is used is important to avoid everything becoming infrastructure. There are therefore mixed responses depending on professional orientation.

Responses from the baseline study simply indicated that design is a profession and that designs lead to the production of an artefact (IT, building, art) of some kind, although it is acknowledged as a process of developing of product or service. Most of institutional designs are top management directed and are expert-led (either local or outsourced), demonstrating administrative power in directing decisions on infrastructure design and development. They also present infrastructure as basically a technical matter that requires a technical perspective. Participation of end users in these cases is less aligned to the participatory design methodology and more exclusively to expert-led designs. Results show that this has generally been the practice in designing and developing infrastructures. Lately, some users at the higher levels are being consulted/integrated in matters relating to their field. I contend that these types of users are being involved as experts from whom expert opinion is collected. They recommend bottom-up and mixed approaches because of the feeling that user participation is valued; unfortunately, the ultimate practice is usually different. This emphasises expert-led designs, as well as management direction, because of off-the-shelf procurement from companies contracted to maintain the technical setup.

In this section, I review a mixture of sociotechnical and sociocultural issues emerging for system design to address. The expert-led approach often follows system development life cycle (SDLC) based on theoretical software engineering (Baxter & Sommerville, 2011) which is structured. However, Mumford's (1983) participative systems design advocates for user participation at all levels of IT system development.

While issues of policies, organisational cultures and beliefs are outstanding as factors that require consideration in the design of ICT systems, the respondents feared that the process could take too long, thus leading to system obsolescence before use. A respondent from UCU cautioned that some IT systems rapidly change, therefore requiring a proactive approach. For instance, he noted, some of their computer systems were rendered unusable because of delays in system setup and testing. Such a system was overtaken by new models in the market. Key findings and summaries from the interview transcripts are provided in Table 6-3.

Table 6-3: Summary of interview data on infrastructure for learning design.

Interview questions	Response Summary
Approach to designing the infrastructure	All respondents agreed that designs are either expert-led or top management directed. They reported having used user-centred, expert-led, user-initiated with support from the management, mixed and purely top-down approaches. In one case, a workshop was held to get user feedback from a prototype.
The recommend approach	While, in the case of Muni, this was built into the university establishment, Makerere, UCU and Busitema experiences recommend an integrated approach (integrate users, designers, experts) with a bottom-up design. The reason is that systems should be supported by technology and have management support which only acts as a guide to the designers.
Sociocultural issues with design	Institutional cultures differ depending on the aim of the establishment; systems need to be interactive and to support Christian values; there is a need for more graphics; policies are being developed as the system is introduced. ICT, work practices, skills training, user support policies were mentioned by the respondents. Staff orientation and motivation and staff resistance to these developments were reported as part of sociocultural issues.

These institutions mostly adopted and used top-down and expert-led approaches to design their infrastructure for learning. In two of the institutions, the design was management directed with consultants identified to design and oversee the implementation process. Otherwise, such an approach leads to resistance, as reported

in the case of lecturers from UCU which led to a decision to appoint a design team composed of experts to engage with the users through a workshop to discuss design options and implementation strategies. A phased approach was adopted in that case to allow user participation. At Muni, a user-centred approach was adopted since the users conceptualised the concept and additionally designed strategies of implementation that went through approval by the university organs. UCU and Muni reported that customisation of the LMS to local requirements was based on a simple survey. This survey documented how to orientate new staff to the new Moodle learning environments. While another institution reported that their eLearning initiatives were based on user initiation resulting from staff exposure and collaboration, Muni was the only unique case where institutional policy was used and supported by management. Lack of financial resources and commitment has naturally slowed down the initiative at Busitema. In all these cases, other than continued professional development, management understanding and support (Kafyulilo et al., 2016) of the design and implementation strategies have been very valuable in sustaining the initiatives.

Designing and planning for IT infrastructure requires the university community to change their mentality about, perception of and attitudes toward ICT. When we plan well, risk factors are reduced or eliminated, which will lead to the success of implementation and maintenance. In the case of Muni University, such an approach was followed from the inception, so staff were continuously being oriented into the main system. In addition, all respondents reported that a carefully managed bottom-up approach is a better way to approach technology planning compared with a top-down approach that has been in use at these institutions. The top-down approach has usually resulted in differing plans of action for implementation as noted by a respondent from Muni. This is supported by the notion that technology should only support a 'good system' and not vice versa. But IT, just like other human tools, should always afford the activity for which it is designed (Suchman, 1985). It should actually not be the case of a 'good system' when higher education is where human resource capacity is built.

Considering user experiences would lead to proper negotiations on key priority areas of ICT in that it would contribute to reduced resistance from the users because they could see progress as they experienced availability of services. The respondents also emphasised the early involvement of the users from the conceptual stage and design. They tended to recommend that top management of the universities should only guide according to user expectations for as long as it remains a good system.

Generally, in two out four of these institutions, ICT policy is yet at the development stage, and so implementation is lacking. Policies are meant to address some of the sociocultural aspects of technology according to a respondent who also noted that they are being supported by the African Development Bank's HEST project to develop IT policy. Apart from the ICT or IT policy (these two terms are used interchangeably), other policies supported by the same project, according to a respondent from Muni,

include work practices, skills training and a user support policy. Makerere University reported that it already has its ICT, ODL and eLearning policies approved, and they are being implemented.

The sociocultural aspect of technology was mentioned by a respondent from one university, but others are now becoming aware of how it could be included in the design of an ICT system. This implies that expert-led ICT system development is strong on the sociotechnical aspects of system development, following from organisational redesign (Mumford, 1983), systems procurement and systems analysis and design (SAD) based also on software engineering principles (Baxter & Sommerville, 2011). However, respondents specified various sociocultural aspects of the system relating to organisational cultures and practice, services to support teaching and learning in these universities, ICT policies, perception, resistance to change, motivation, institutional culture, cultural values, graphics and colours in the design.

6.1.4. IMPLEMENTATION OF THE DESIGN

Public universities in Uganda by law are semi-autonomous government departments under the Ministry of Education and Sport. These institutions plan and implement activities relating to all institutional development and sustainability. Implementation strategies are dependent on the institution administration and institutional strategic plan which are approved by the Ministries of Public Service (human resources), Finance (finance) and Education and Sports (education). In some cases, as reported previously in this chapter, they depend on the collaboration between the institution and other institutions through collaborative and development projects. These institutions are at varying levels of implementation of their designs of infrastructure for learning. I found that Makerere University plays the central role as the oldest institution in the design and implementation of most of these systems mentioned in the survey. In two cases of participating institutions in this survey, their projects led to the design and implementation of the technology-enhanced learning, and these were based on a collaborative project with Makerere. One respondent from Busitema also argued that many of the staff in other institutions were either trained or previously worked at Makerere before getting employment in these public or private universities. This reaffirms Makerere's position in shaping the development of systems in other higher institutions of learning in Uganda. For example, according to Kiguli-Malwadde et al. (2006), the medical faculty developed the PBL. This was done to achieve the goals and the mandate of higher institutions of learning. The faculty organised study visits to universities in East Africa (Moi), USA (New Mexico), Europe (Maastricht) and Australia (Newcastle) which were already running programmes based on PBL.

The challenges reported here are quite universal to such institutions. Issues of electricity, bandwidth, staff attitudes and perception were easy to come by according to all the interviewees. The issue of commitment and job security was alluded to by some of the respondents, as in the case of UCU. This implies that there is lack of

adequate training or basic awareness of how technology works, what it can and cannot do and how it relates to our practices. According to one respondent form UCU, resistance to change is human nature that needs a more pragmatic approach than systematic organisational and collective involvement of all groups of participants. One respondent intimated that there is the need to force people to learn new technologies as a way to experience change, specifically for staff in non-science disciplines. They also noted the fact that the age of the lecturers somehow plays a role in their perception to technology, with older ones being more resistant than younger ones who they say use the technologies more regularly. Table 6-4 presents the summary of responses.

Table 6-4: Implementation issues of infrastructure for learning at institutions.

Interview questions	Summary
Challenges experienced with implementation and use	Technical problems; feedback from the users and administration; stable electricity supply; need for high-end devices, low bandwidth and stable internet connection; availability; poor infrastructure; cost of hosting; technology very expensive; limited access to technology by users; user acceptance especially from social sciences fields a case in one institution; need for better hardware; training lecturers; need for more exposure
Proposed explanations or solutions	User response should be quicker to allow for improvements on the system; involve users in the design phase until implementation; synergise with other institutions; improve system response time; train end users and technical personnel on the system; management and administration support; workshop on the benefits of ICT to teaching, learning and other administrative functions of these institutions; advocating for change through the use of ICT
Further comments of technology-enhanced learning	The need to study affordances of these systems to the teaching and learning and other university functions;

	technology should help cut cost of operations and make people happy at work; universities (staff and students) need to embrace blended learning; government should increase funding to support institutions championing Technology Enhanced Learning (TEL); people are resistant to new ways of working so they need to be pushed, especially older generation; need for more financial support, planning for maintenance of the investment in the technology and staff training

The institutions are at different levels of implementation of blended learning and ICT infrastructure, most probably based on their prioritisation of resources and planning. The respondents expressed challenges in the implementation phase relating to the lack of IT technical expertise, feedback from users (both staff and students in institutions where implementation is underway) and lack of adequate administration and/or management support to technology-enhanced learning initiatives, lack of electricity supply leading to running expensive generators, outsourcing services such as hosting, currently low bandwidth, internet instability (unreliable and unavailable), technology being very expensive (servers), user acceptance or resistance, especially from staff of social sciences, lack of high-end hardware servers and lack of exposure of staff and training of staff to using the systems.

Respondents proposed mitigation measures that included involvement of users from the inception, design through to implementation phases and the need for universities to synergise with other universities and institutions of higher learning locally or regionally who are already using such a system. Further, there is the need for constant teacher professional training as end users and the training of technical teams to support the use the tools (generally staff training), and the management on these institutions has to support technology innovation and acquisition of tools. All people working in higher education institutions need to learn how to use technology and the staff should stop seeing technology as a threat or risk to their jobs.

Summary

Universities in Uganda are responding to the need to embrace technology-enhanced learning. There are initiatives from staff to adopt technologies in the running of universities to improve service delivery and access to higher education. This however is underlining the need to share resources, collaborate and involve all stakeholders in

the design and development of new solutions relevant for the Ugandan environment. The institutions are at different levels of realisation of their goals to adopt technology, with Makerere leading the charge as it has had its ICT and other policies approved and implementation in the ODL and eLearning at the College of Education since 2015. Being the oldest institution, it has gone through cycles of attempts to adopt technology. The university is running a Moodle-based LMS, its MUELE system. This is one of the first of these systems to be used in a public Ugandan university. Many of the staff in other universities either worked or studied at Makerere, so the design and implementation of blended learning systems are similar in the other institutions to those of Makerere. Like Makerere, Kyambogo University has an approved ICT policy published on their institutional website, which was effective as of 2015.

Based on their experiences, the respondents recommended that technology-enhanced learning is a good way to improve teaching and learning. Learning is happening as the technology-enhanced learning is slowly being adopted in these institutions. eLearning is new to Ugandan higher education, and with few policies in place to govern it, this presents a complex situation to the teachers. Therefore, the management of the institutions should adjust to technology, make appropriate policies and devise effective strategies and accord it adequate financial and moral support to reduce the risk of failure. Blended learning and eLearning initiatives have been reported to often fail in developing countries (Ssekakubo et al., 2011). The initial cost of investment is notably very high in Uganda and maintenance cost of ICT is still a problem in developing countries. The respondents agreed that it is possible to implement LMS-based blended learning that can support teaching and learning based on the pedagogy and curriculum. They argued that eLearning can increase efficiency (results), reduce cost of operation, increase flexibility and access, somewhat improve performance (makes students happy) and increase scalability and transparency (audit trail).

They also noted that the world has become a global village with the discovery of the internet, so the lecturers should embrace eLearning and blended learning in our institutions. They stressed that the government should allocate more funds to support institutions that are championing the use of these technologies to increase access and improve the quality of education.

However, they also noted the problem that some people are not willing to learn new things, and so there is need for a more pragmatic approach to get people started with new tools. This agrees with Ssekakubo et al.'s (2011) point that failure of the LMS initiatives is not directly related to the technology but is aligned with the lack of strategies to use such technologies to support students learning.

6.2. PRESENTATION OF THE INTERVENTION CASE

In this section, I present each of the research activities and how they were implemented at Gulu University. This university's history and its motto 'for Community Transformation' are factors considered make it a relevant case for the study for blended learning. Being a recent establishment with limited resources, the capacity building and collaborative projects addressing infrastructure development provide a good environment to research how infrastructures for learning can be designed. Gulu is a resource constrained environment with few IT technical staff, poor IT and a limited physical infrastructure. With blended learning still a new concept at the university, studies of IT infrastructure development and staff perspectives about designing IT infrastructures present an exemplary case. A combination of new PBL pedagogy, blended learning and technology-enhanced learning engages users in constructing a new and relatively complex IT infrastructure design for their activity of teaching and learning. The data collection and presentation will follow based on each of the methods used in the workshops.

6.2.1. FUTURE WORKSHOP: EXPLORING USER PRACTICES

FW is a method that is strongly affiliated with the transformative paradigm. It attempts to empower participants to advocate and democratically respond to the issues of the future. This has been referred to as a useful research strategy for the future (Engeström, 1987). The transformative paradigm is known to be strongly associated with change, empowerment, advocacy and political emancipation (Mackenzie & Knipe, 2006), which are shared principles of the FW. Using this method to address past, current and future issues will make subjects become aware of what Engeström (1987, p. 125) termed 'the contradictory nature of their present work activity and relate to the future form of work'. This method is transformative and is not directly part of expansive learning, but it has been used previously used in studies relating to CHAT (Kinley, 2015) and PD.

In order to understand the past, current and future issues and related actions, FW as a method and as a technique was used within a project activity conducted with selected participants. There were two Workshops One in August of 2015 and in January of 2016. The workshop was designed to stimulate thinking about the desired future, but also to understand some of the historical issues that have led to current trends. This workshop provided the teachers with an opportunity to digest the need for the desired change and contribute to it. Participants in this workshop were purposively selected from amongst the teaching staff, administration, management and IT support domains of the university. Participants noted that it is true that change of practice is a complex process that is intertwined with daily activities of managing an institution. Management staff, consisting of the deans, and teachers represented stakeholders in their respective capacities, together with those in administration. The participation of

all staff categories in these workshops translated to the initiative of institutionalising the project activities and the change process.

The FW fundamentally had four phases: the preparation, critique, fantasy and implementation or realisation phases (Jungk & Mullert, 1987; Lauttamäki, 2014). However, the preparation phase was undertaken by the facilitation team and organisers of the workshop before the actual workshop, thus setting the stage for the other three phases from which data were collected. The FW was a new method in the research environment of the university. The workshop was organised to start with a short presentation of the theoretical and practical perspectives. Although this was not part of the data collection process, the workshop began with a presentation by our Danish partners (Professor Lone and others) who related the method to PBL pedagogy and some aspects of the twenty-first century skills. Professor Lone elaborated on four key elements of these skills: a) Ways of thinking: building on the need for creativity and innovation (building in problem formulation), critical thinking, problem-solving, decision-making, reflection and interdisciplinarity; b) Ways of working: communication, collaboration (teamwork) and action research; c) Tools of working: digital scholarship, ICT for learning, tangible objects or projects; and d) Living the world: life and career, as well as personal and social responsibility, including cultural awareness and competence. This elaboration was done by this professor who is from Aalborg University, Faculty of Humanities which is partnering in the BSU project. The workshop presentation set the focus on the theme of engagement and the need for designing and adopting learning to deliver solutions to the challenges of our future workplace.

This was the first time an FW was organised as an empirical method. The BSU project partners from Aalborg introduced the method to participants in the workshop. It made participants engage with cultural past, current and future activities of teaching and learning moving toward student-centred learning. Participants identified and discussed the need to adopt new pedagogy in response to the twenty-first century challenges and graduate employability. Prior to this workshop, there were other workshops that introduced the PBL and eLearning and discussed their applicability to Gulu University's situation. The workshop members had then agreed to the introduction of new pedagogical approaches based on PBL and eLearning. This set the point of departure of this workshop to investigate the problem critically and thoroughly, create possible futures and deliver practical solutions and action plans. This made the FW an excellent way to start discussions.

Participants were invited to the workshop through the BSU project coordination team following the previous workshops. Participants were selected based on voluntary application through mail to participate in the workshop. In previous workshops, the participants had agreed to introduce this as a pilot university degree programme that would have to undergo the due process of accreditation. This implied that the workshop needed to identify current challenges with the programmes, visualise

possible futures and document practical solutions. Due to the complexity of the curriculum development, participants were purposively organised in groups based on their expertise, interest, professional domain and background. Based on prior workshops that resolved to adopt new ways of teaching and learning (PBL and eLearning), the objective of this workshop was to i) establish mutual understanding of the vision, ii) explore barriers to realising the vision, and iii) develop a road map of activities to accomplish this vision. In a short introduction, the workshop facilitators introduced the technology for designing the future learning environment. Output from the groups in the critique phase was described as it had been for the other phases. Using the CHAT, I analysed the phases of the workshop to understand and explain how this activity related to infrastructure design for learning. I will describe in detail each phase of the workshop and activities in relation to infrastructure.

6.2.1.1 Workshop Resources

Participants were provided with A1 paper and flip charts, marker pens, sticker papers of different colours, notebooks and pens for jotting down important points during the discussions and the programme. The workshop followed the standard description of the method in a step-by-step manner as is described here.

6.2.1.2 Detailed Future Workshop Phases

Critique phase

In this phase, the facilitators introduced participants to the existing programme, its current state and the need to redesign it to include innovative pedagogical models and to integrate technology in the teaching and learning. Five groups were formed with members purposively selected to include all backgrounds. The five groups in Future Workshop I were organised around the themes: a) staff, b) infrastructure, c) students, d) knowledge and pedagogy and e) university management and administration. This thematic distribution was designed to maximise the use of time and to achieve the goal of getting various perspectives as projected in the workshop design and objectives. This organisation of the workshop took into account all of the stakeholders in the university and the core functions of teaching, learning and community outreach. This grouping then continued on into the fantasy and realisation phases of the workshop. This formation was meant to address the requirements and content of new programme(s). I will selectively summarise the reports from groups involved in this study.

Each group was allowed 45 minutes to discuss each of the themes and to then compile a report for the plenary session on their findings from the critique phase. Selected group leaders organised and presented their outcomes. Group 2 informed participants that, based on the three main activities of the university, teaching, research and outreach, they had critiqued the method of teaching as varying from faculty to faculty.

They also noted that there were issues of negative attitude of the lecturers in the faculties. One participant described the challenges: '…the challenges in achieving the goals are different methods of teaching and different approaches and attitudes of lectures'. And, another participant commented that: '…the recruitment process of lecturers is not uniform and sometimes does not follow the right method'.

The issues surrounding recruitment may be considered one of the challenges, but I will only note it or future references. Another participant took on the issues of strategy of teaching based on the current pedagogy and preparation of the lecturers as one of the major setbacks in the current settings. Another commented that 'The problem is lectures have not been using systematic strategy for pedagogically prepared material for community transformation'. While members of other groups agree with these, Group 4 added that the university teachers are not settled at their jobs. One described it as 'teachers keep running up and down'.

They may have been intimating that the problem of not having adequate time to prepare for their lectures leads to failure in achieving university objectives. Members of Group 5 blamed some of the challenges on curriculum being based on teacher-centeredness and classroom restrictions. One noted that 'Our curriculum is teacher-centred and classroom-based'. This participant may have been directing members' attention to a student-centred learning or more practice-based learning that takes place outside of the formal classroom environment.

Participants complained about the teaching and learning environment as being poor and under resourced. They noted that lecture rooms are not big enough and lack amenities for lectures, the library resources are mainly unavailable for humanities and social sciences (these include eBooks and physical books) and ICT services are below standard for the university.

Generally, the groups reported an elaborated list of reflections on the current master programmes at the university and how they have been using technology to facilitate their teaching and research. The participants exercised the opportunity to collectively reflect on the programmes they teach and their challenges. Many of these challenges about technology were similar and revolved around lack of internet bandwidth, computers, physical space, library resources (both electronic and physical books), staff training, students' lack of exposure to such systems and problems with curriculum realignment to ICT.

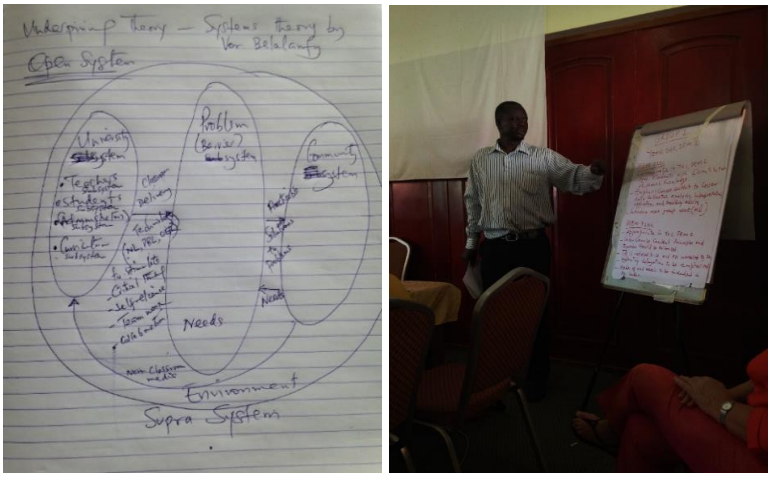

Figure 6-1: (A) Illustration of how university is part of the suprasystem from Group 3 and (B) member of Group 2 presenting the group's critique points.

Specific to the subject of redesign, Group 3 identified gaps and weakness in methods of teaching in the programme which should be strengthened in the redesign. They noted that all the programmes are based on the traditional teacher-centred approach without seminar presentations or individual/group fieldwork activities. They also listed a number of problems that needed to be addressed: students' inability to internalise the concepts taught in class; the content lacking ways to encourage students' creativity; the time allocated for the course delivery being too short because the programme is on the weekend; the format offering no time for students to perform practical sessions and share experiences; the assessment method needing to be improved because in its current form, it is prone to plagiarism and reproduction of lecture notes; and students normally developing phobias for tests and examinations. They emphasised that no research projects are given to students during the teaching semester.

Participants presented the institutional critiques of adoption of blended learning and strategies to mitigate these challenges in order to achieve the desired outcome. Critique points included lack of relevant policies, negative attitudes toward eLearning and a limited budget, and they suggested strategies such as curriculum review, developing enabling policies and involvement of stakeholders, and others. Figure 6-2 presents the summary of their discussions.

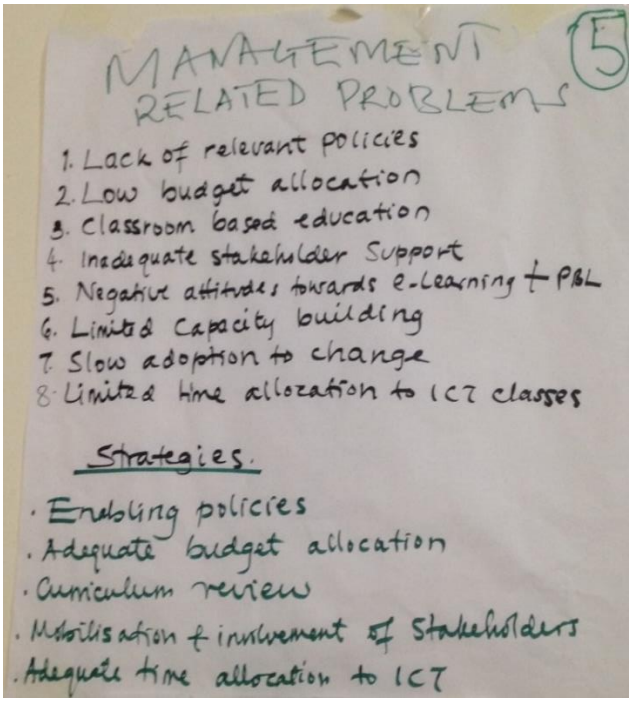

Figure 6-2: Some of the critique presented by Group 5.

In summary, all the groups agreed to the curriculum being redesigned with an emphasis on student-centeredness and that research should include at least five credit units (5CU) because of the nature of its practicality and exposure to real-world problems. They also agreed to the improvement of infrastructure (both IT and physical) in some of the critical points. The workshop discussed perspectives and challenges from all the groups and ranked the challenges in terms of importance. This ranking formed the basis for the next phase. This was done as a control measure to keep the scope of the workshop focused and in context.

Vision phase

In this session, participants came up with their mixed ideas of the proposed visions which they called solutions, alternative views and desires of the future. Zeroing in on their recommendation to incorporate blended learning (PBL, eLearning and networked learning), participants focused on proposing designs advocating for student-centeredness.

The critique of the traditional approach opened opportunities for rethinking the future of university graduates. For example, Group 2's vision of having student enrolment from all over the world with a mission of providing an enabling ICT infrastructure to

facilitate global NL underscored the need for embracing ICT. They proposed improving IT systems (hardware, software, networks), content development, technical support, personnel to manage these systems and Moodle as a LMS. One participant stated: '…we propose Moodle as a learning management system, hardware, software, technical support, content development and personnel to manage the system'.

The group envisioned the university as having stable and good internet connectivity and designed a strategy to reduce maintenance cost of these artefacts by transferring the cost to the students, instead of setting up computer laboratories. One noted they needed to 'advocate for stable and good internet connectivity for these systems', and another added they that needed to 'move maintenance of hardware and software to the learners by using the "bring your own device" concept'.

BYOD is a concept that was reported to have worked well in other universities (for, example, at Muni, based on the survey) and that it reduces cost maintenance of the computer laboratories. The BYOD idea also corresponds well with the current inadequate staffing of the IT support unit at the university. The unit has three staff managing the IT infrastructure and services. These personnel have competencies in the general IT support function, but are also dedicated specifically to network management (one person), hardware (one staff) and Web technologies (one staff), thus leaving software and applications services in need of some staff. Of course, there is more to this ICT profession that cannot be covered here, but there is a distinct need to strengthen the human infrastructure.

From the students' perspective, Group 3 emphasised the university's need for computer literacy and integrating social media in the LMS because students like to stay on social media for networking purposes. They argued that it is important to interest students in using social media for academic purposes. They presented a proposal for more access to online learning facilities, which will gradually reduce pressure on the physical facilities of the campus. Group members noted in their vision statements that 'there is need to establish online facilities, for example, online course content' and that they should 'decongest the classroom by introducing e-campus'.

Further, the proposal for an e-campus reaffirms the vision of Group 2 dealing with infrastructure for learning that will allow for student enrolment from all over the world. Group 3 noted that the university is situated in a community environment that they considered a suprasystem. Because of the numerous problems, it was proposed that students become an avenue for the university to attend to some of those problems, to address them as part of students' outreach programme. Through the faculty of Education and Humanities, the group proposed that some the philosophy of PBL and NL could be introduced at lower levels in schools. A presenter from the group commented on this possibility:

> Introduce students at primary and secondary schools to the philosophy of a networked learning environment based on PBL. This is in line Gulu University's mission for community transformation, and it would prepare students for the changing trends to a networked learning environment based on PBL.

This voice was emphasising the university's mission to transform communities through education at lower levels. The idea of students beginning to collaborate at an early stage during their education, based on the principles of PBL and the use of ICT, was a motivating idea for the group.

Lecturers will need further training and scaffolding in the area of eLearning and PBL by the collaborating universities in the project through expert facilitators. All staff were trained in the traditional teacher-centred approach, and thus Group 4's vision was to train the staff in blended learning pedagogy. Also, they reported limited knowledge on NL and PBL, and that teachers will need to generate more knowledge other that what they have accumulated based on current practices.

Group 4, however, decried the problems of high student–lecturer ratio, inadequate teaching and learning materials and low internet connectivity. The student–staff ratio is a very relevant factor for PBL because, in principle, effective student supervision may prove impossible for the few staff who teach in these programmes. One participant reported that, in one of the courses, there are about 300 students, and they must use loudspeakers in the main hall: 'In one of our courses in foundation of education, there are about 300 students that one lecturer has to teach. How can we do this in this PBL?'.

This underscores the importance of effective implementation of PBL strategy but presents a situation that requires team teaching as opposed to the individual expert teacher scenario as was reported. The single teacher per subject (course unit) in the department was the noted as being due to understaffing. Although the participants encouraged team teaching for such cases, there was no other alternative to handle such challenges by the faculty. The present design of the lecture space even challenged the use of projector and chalkboard that are popular in the teacher-centred approach. The tools simply are not appropriate because the students were reported to even have to sit outside of the room while attending lectures. This raises an important question on how to effectively use PBL when scaling up and PBL in large classes in the context of resource constrained settings. The use of Moodle infrastructure would surely provide a smart interactive virtual environment for sharing content and students' interactions compared with the use of loudspeakers.

Each of these groups created vision maps, but for simplicity, I have chosen to sample from the group presentations a few illustrations for clarity and empirical evidence.

Figure 6-3 is an illustration of the visions of two different groups presented on their posters.

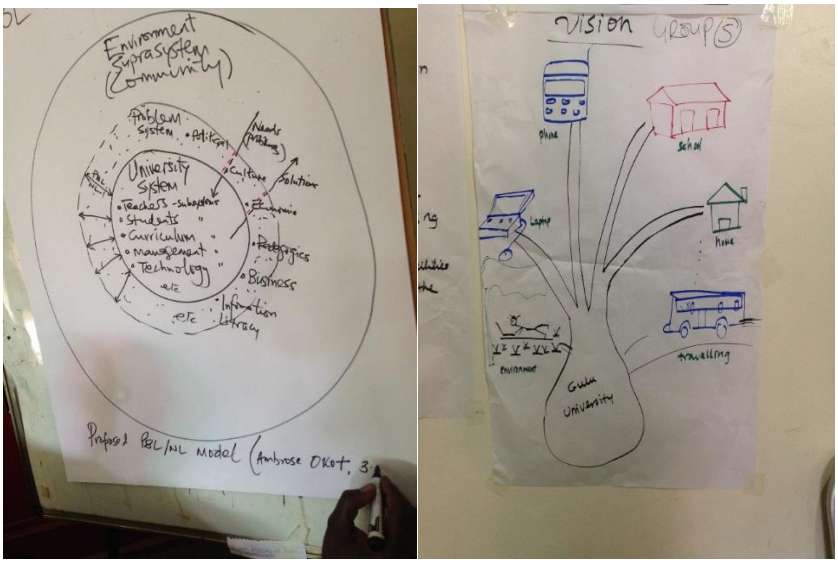

Figure 6-3: (A-Left) Illustration of how the university can contribute to the community through PBL and NL from Group 3 and (B-Right) vision map showing how the university could participate in the transformation of the community from Group 5.

Participants came up with a drawing for each group depicting its vison. Group 3, for example (Figure 6-3A), came up with a systems concept in a drawing which identified barriers to the system and attempted to propose ways to identify needs. The group positioned the education system within an open system they termed as a suprasystem that included the university system with its subsystems (teachers, students, administration and other resources), and a problem subsystem which included barriers, needs and the community subsystem. The group argued that education system should be capable of working with community in identifying challenges that affect the community and designing workable solutions. In collaboration with the community, students would propose projects and work to present achievable solutions relevant to the local context and to the direct beneficiaries. The group showed how critical thinking, teamwork and collaboration could be emphasised as part of the delivery system for the university to contribute to a solution to community problems.

Group 5 concentrated on the university's needs to redesign its programmes to respond to the community's multitude of problems. They envisioned the university as a tree composed of branches as in Figure 6-3B with each branch representing unique challenges or problems (school, transport, technology) that require university intervention through active research and engagement. This vision placed the

university at a unique position in response to how community problems could be collaboratively addressed through the use of ICT.

The vison of Group 5, as illustrated in Figure 6-4, showed their proposal on how technology could be integrated in the teaching and learning at the university. They proposed to model the institution as a champion in eLearning and PBL. In their proposal, they urged the management and administration of the university to make a commitment to implement policies, collaborate and work with stakeholders, engage staff in the implementation of these policies and solicit funds for the strategies proposed in the policies. Their presentation emphasised 'stakeholder mobilisation, collaboration, engagement and enabling policies'. They presented a flow diagram with the goal, vision and mission that also sketched requirements for the goal to be achieved as depicted in the figure.

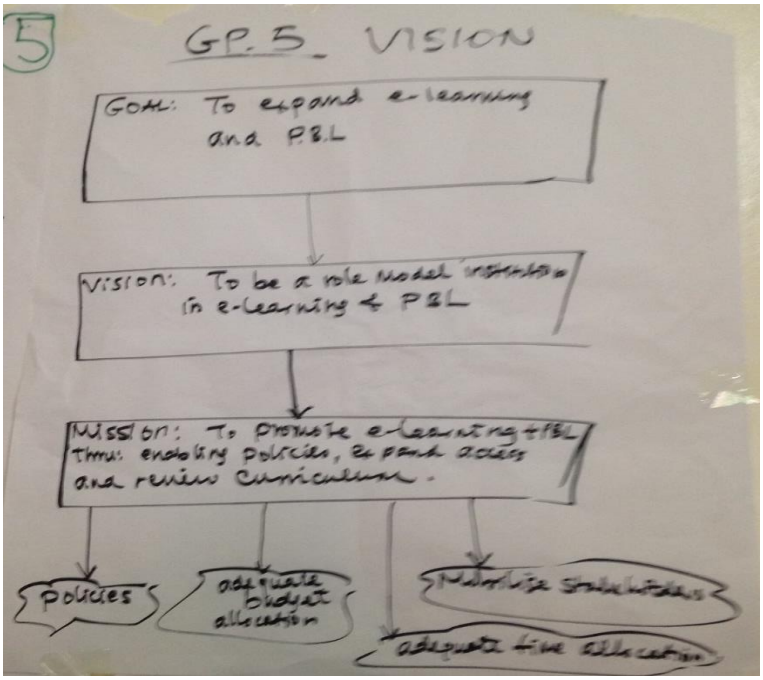

Figure 6-4: Shows the vision based on illustration of Group 5.

The mission here was to develop enabling policies to allow for the university to expand access and also to review its curriculum to accommodate for the new ways of learning. Requirements identified by this group, as indicated in Figure 6-4, included policies, adequate budget allocation, time and stakeholder involvement as the foundation to realising the goals of integrating and expanding technology-enhanced learning and PBL.

In summary, the groups presented their vision based on the objectives of the courses and resources required to deliver these courses (e.g. Group 2), identified ways of strengthening the method of delivery (e.g. Groups 1 and 2), and emphasised the need to adopt interdisciplinary and collaborative technique, PBL and blended learning through a pilot programme. They also acknowledged the need for team teaching with related course units grouped appropriately to provide enough knowledge for students. Also, all groups provided evidence of the lack of IT services (internet connectivity) and adequate teaching and learning materials, and they stressed that the university needed to adopt more practical approaches to teaching and research for the students to build confidence through peer-learning and interaction with community (Group 4). Stakeholder involvement at all levels in the design and implementation of these programmes was noted as lacking and needing to be addressed along with appropriate budget allocation by the university. The BOYD idea was welcomed by both IT support and technical staff. The workshop participants appreciated the amount of work that would be placed on the IT support staff once all these programmes were running, which made it logical and appropriate for the BOYD to be adopted. It was also noted that the cost of technology was becoming much more affordable for all students, especially the masters students.

In all, the participants presented their perspectives on technology integration in teaching and learning at the university based on the current situation and use of IT. PBL and other ways in which innovation, collaboration and critical thinking skills could be incorporated in the programmes to make them more practicality-oriented with a focus on contributing to community transformation were stressed.

Realization phase

As a prelude to this phase of the workshop, a short 5-minute presentation defining what should be done and the expected output from the groups during the phase was made. We need to recall that this technique was new to all participants, so such presentations were necessary. Participants then broke into groups after collecting all resources they would need to facilitate their group discussions. After another 45 minutes, the five groups presented their views and proposed implementation strategies.

Presentation in this phase was structured to respond to Why, How, What, When, Who, Where and How, as well as serving as a guiding framework for the participants. Figure 6-5, an illustration from Group 5, indicates how the group discussed these aspects. The commitment and policy cases (what) are made stronger to top management and the heads of cost centres. One can see that the proposal is made to integrate new ways of learning up to 50% in the existing and new curriculums. It gives an idea of a more progressive adoption of PBL and blended learning as lecturers gain more knowledge and experience with the pedagogy.

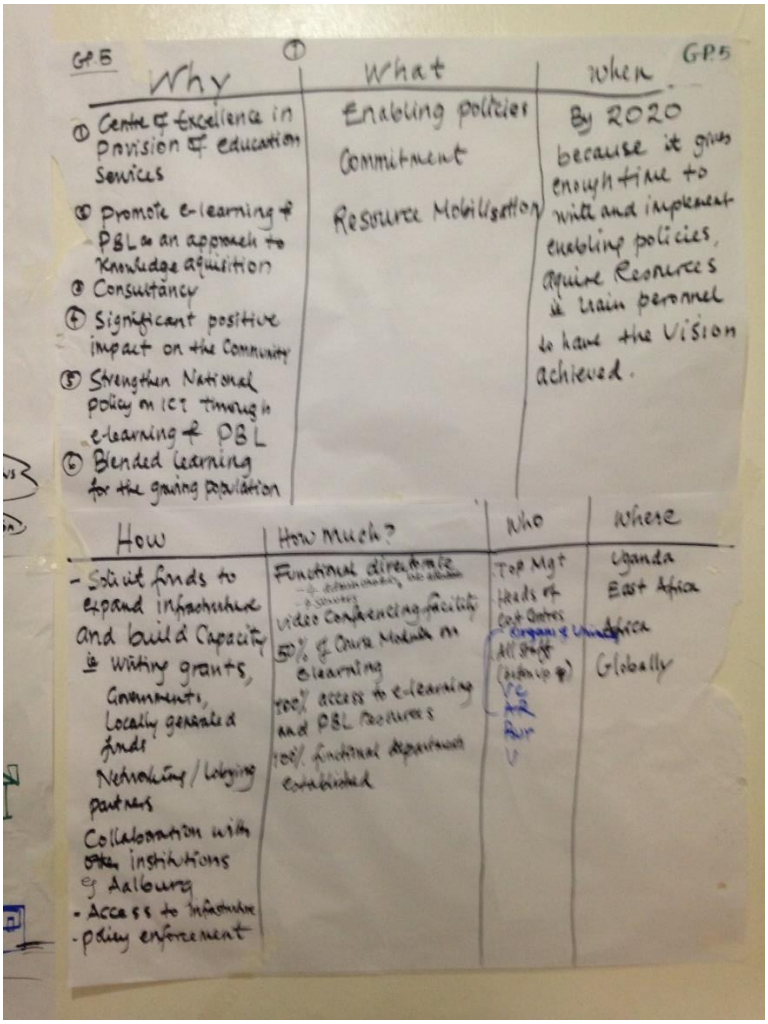

Figure 6-5: Illustration of the realisation phase by Group 5.

In Group 5, presented the need to promote eLearning and PBL and to strengthen ICT policy and blended learning to make the university a centre of excellence in the provision of higher education services. They also recommended improving the current infrastructure for learning that affords these new ways of learning through collaboration with other institutions and policy enforcement. Different stakeholders were identified from internal structures of the university (academic registrar, vice chancellor and top management), as well as from external bodies, such as the National Council for Higher Education, Ministry of Education, ICT, NITA-U, other universities and regional local governments.

Groups 2 and 3 made proposals for realisation of the required IT infrastructure and resources that would lead to systematically achieving the goal of adopting blended learning and PBL (student-centred learning).

Table 6-5: Summary of the realisation phase from the workshop.

Why	**What**	**When**	**How**
• Minimise space challenge • Increase enrolment • Reduce costs • Improve visibility • Adapt to change	• Improved connectivity and bandwidth • Human resource skill • Hardware and software	From 2016	• Provide more funding • Policy • Short courses • MSc • PHD
• Lack of bandwidth • Inadequate ICTs • Limited accessibility • and affordability • Dependency syndrome • No encouragement of eLearning	• Engage students • Online content development • Collaboration with schools • Structure problems	Immediately, as there is a need to improve accessibility, develop content, collaboration and engage students	• Formation of learning groups • Train more trainers • Intrinsic and extrinsic motivation • Participatory and stakeholder-driven learning

The group presentation noted that the cost of bandwidth was too high and that the management needed to seek alternatives other that procuring it from the telecommunication company. This could be achieved through implementation of the minimum bandwidth requirements stated in the NCHE guidelines. However, a participant from the IT support unit stated that the 'national level does not have minimum level to be followed'. It was therefore suggested as prudent to follow the NCHE guidelines as a baseline to seek for more funding for bandwidth from government or development partners.

Other groups presented their implementation plan describing how the courses should be organised and how these courses can complement each other. Their main suggestion was to start with a blended approach that incorporates all models (PBL, eLearning and traditional pedagogy) in the coursework. The coursework is currently composed of tests, extended essays, small group projects, assignments and other

activities, depending on the which discipline offers the master's programme. This coursework in the master's programme usually contributes to 50% of the total mark for the course in a semester and 40% for all undergraduate programmes. As an example, Group 2 felt that the current teacher-centred lecture method was still important since the students have been using that system up to and into the university level. The group then proposed that all these must be blended with slow migration to the PBL with integration of technology-enhanced learning. This proposal was reaffirmed by Group 4 who argued that all lecturers were trained in the traditional teacher-centred approach and would need to get more training and knowledge to grasp the PBL well before embarking on using it as an institution. One group member noted that 'we still have knowledge and pedagogical associated problems. Most teachers are trained in the teacher-centred method.' Another participant noted that preparation by the teachers based on the current teacher-centred approach was a problem: 'Problem is lectures have not been using systematic strategy for pedagogically prepared material for community transformation'.

This input seems to disagree with the move to adopt new pedagogical approaches and that the problem of not achieving community transformation is based on the lecturer's lack of proper preparation. The lack of preparation, in essence, affects teaching and learning, and thus, the prepared material is not aligned with pedagogy and the university motto for community transformation. The group that concentrated on course organization in their discussion argued that both e-Learning and PBL have not been their practice and have not been used by teachers. Their evidence is that all programmes at the university are designed and based on the teacher-centred approach. However, the participants agreed to move toward these new ways of teaching and learning because it would be good to have organised PBL in a country such as Uganda which needs to address its problems of development and employment.

Participants recommended that the university should start with design and implementation of new programmes and progress slowly to currently accredited ones. They also agreed that progressive integration is good since the teachers themselves need continuous capacity building at the same time. From the technology perspective, they also noted that the current technology and infrastructure needed to be improved to handle these proposals with blended learning.

It was evident from the discussions that the current ICT infrastructure is too poor to deliver the affordances proposed through PBL and blended learning. It was recommended that the country requires financial and management support of the current budget and should allocate financial resources specifically for internet bandwidth and computers. The participants represented all internal stakeholders (except students), and as an administrator noted that the university is operating under resource constrained settings, they recommended a careful and simple implementation strategy: 'In the meantime, we can use all the electronic devices we have to start

integrating e-learning or network learning. This will help the university to be integrated in the international electronic community'.

A step-by-step systematic approach undertaken collectively with stakeholders is important. Effective communication amongst management and staff was noted as key to the success of the implementation and sustainability of the PBL and blended learning, especially with the proposed IT systems. At the same time, it was also suggested to start with addressing the social aspects of change, which was noted as a challenge for most staff at the university. The key to this was the attitude of the staff toward the use of IT as a tool to improve services at the university. To realise the vision of eLearning or NL, academic and administration attitudes must change. Group 5 had the vison to make Gulu University a hub for blended learning (NL): 'We should begin by attitude change by working toward our vision for becoming a hub for a network learning environment'.

The overall process will need to fulfil some of the user requirements for the proposed blended learning and for IT infrastructure, eResources, space, furniture, books and the LMS. Many of these are requirements, such as policies, IT infrastructure, learning resources and staff development, which are at the macro- and meso-levels of the university. Table 6-6 is a summary of requirements based on infrastructure.

Table 6-6: Summary of requirements.

Case infrastructure	Requirements
Curriculum	Redesign the curriculum with the principles of PBL and blended learning, content development, accreditation
IT	Improve network, bandwidth, access, computer (hardware and software), LMS based on Moodle, overall design
Personnel	Training of IT support, expert, administrators, academic staff (ICT skills, PBL and online course design), continued support by Aalborg University and Maseno University.
Policies	Develop ICT, eLearning, end user, IT management and security policies
Resources	Library eResources, physical books, classrooms and LMS

6.2.1.3 Meaning Condensation

Data from the FW were composed of field notes, audio, workshop reports, discussion materials (presentations and sketches on paper and flipcharts) (Table 6-6) and video. However, video data were not used in this research because of the specific research focus and lack of technical competency of the researcher to analyse such data. The workshop material sketches, chats, audio recordings, field notes and workshop reports were considered adequate sources of data for this research. The audio data based on presentations and discussions in plenaries were transcribed and reported. The field notes were taken by each group during their discussions, and a workshop rapporteur compiled notes, as well as that the researcher who documented the sessions. Simple open coding was done to choose the discussions and submissions that were related to the use of technology (eLearning, computers, infrastructure, bandwidth, internet, eLibrary, blended learning etc.). A summary of this discussion is in Table 6-6, showing the requirements for PD.

The workshop resulted in recommendations that would be very useful to informing curriculum design and delivery methods. Despite the varied cultural and social backgrounds of the team, the workshop was successful in harmonizing the goal of adopting blended learning and student-centred approaches such as PBL. Cultural diversity will mean different disciplines of study and teaching in these departments will need to use technology and modern pedagogy. The participants' level of knowledge, interaction and engagement with technology-enhanced learning and PBL prior to this workshop provided diverse insights. Most of the participants had little knowledge of blended learning. This was evident in that there was a mix of terms that referred to technology-enhanced learning, such that eLearning, networked learning and blended learning were taken to be the same for the purpose of the workshop. Moreover, when the introductory presentations introduced networked learning and PBL, the participants had difficulty in differentiating these terms.

This data showed that participants appreciated the approach, the process of reflection, and the experiences of using the current status to plan for teaching and learning to respond to some for the twenty-first century skills that could come through embracing innovative pedagogies. This method gave the participants an opportunity to democratically participate in the process of change that ultimately will lead to transformation.

There was also an indication, based on the engagement with the activity, of how to introduce ICT and, more generally, technology-enhanced learning in their resource constrained settings. For example, one of the participants asserted that 'Curriculum is teacher-centred and classroom-based. Lecturers have to move from one campus to another, so travel, time and preparation time are all challenging. The workload becomes heavy'.

This seems to agrees with the concept that the use of ICT would help reduce complexity, time and workload on the academic staff. At the same time, the participant proposed that curriculum needed to be redesigned to accommodate for these pedagogical approaches. This was also related to another participant who said that 'Teachers keep running up and down', implying that the current pedagogical approach is quite demanding for teachers when they are on the campus.

Taking curriculum development as an activity within the activity system, the division of labour for the teachers will have to be reconsidered if they are to develop new or redesign curriculum, prepare course materials and content, administer the course delivery and complete the grading. The curriculum should describe in detail the courses and resources required. Management and administration ensures that classroom space, finances, IT infrastructure, IT services and support are provided and that the courses are accredited. The activity of curriculum redesign or development can be represented using AT. AT could be used to understand this process, as illustrated in Figure 6-6, based on Engeström's second generation of AT.

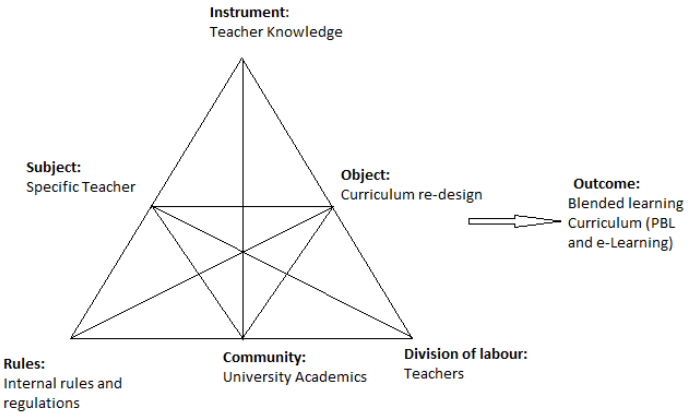

Figure 6-6: Curriculum redesign as an object of the activity.

It can however be realised from the discussions, that the teachers struggled with serious questions as to how to integrate the PBL into the curriculum, how much content and time to allow for PBL and eLearning in the new curriculum and how technology can be integrated. Another difficult issue was division of labour amongst the teachers and support staff on data security for their course information on the LMS. Some teachers felt that by uploading all their course materials, the department could then assign such a course to any other staff, rendering them jobless or given to toil to develop content for a new course. This implies that teachers are not willing to share a course that they have been teaching for a long time and have developed mastery of its content, and that they are directly opposed to team teaching. I will return to this at the

design phase for the Master of Education Planning, Management and Administration in the Faculty of Education and Humanities while discussing it as a case.

The eagerness to adopt a new pedagogy was very evident in the comments by the participants. Some of the staff, however, contradicted this by expressing individual interest to control the courses in the programmes. They argued that the course units should not be altered or combined because this would make them too broad. An example here is a course on research methods which is split into two units (qualitative and quantitative) in the current curriculum and is being handled differently by different lecturers in a semester. This, to others, looked a like a duplication, so it was suggested that it should be combined, and the lecturers should share the teaching load, supervision and examination. Another contradiction involved a complaint about increased workload based on the proposed student-centred approach using PBL and blended learning. The reality, according to the participants, is that there is resistance to embracing group teaching amongst the faculty. Individuals want to continue with the same load, and yet, with the new approach, course delivery could easily be shared, thus reducing the workload.

It should be noted that all the participants were educated based on the traditional teacher-centred approach. It can then be logically understood that their knowledge and practice of PBL are limited and need fostering. Thus, an arrangement for participants to be introduced to the new pedagogies in a stepwise manner would be currently appropriate. Otherwise, other lecturers may also underscore the need for individual financial gain based on the current arrangement where payments are made based on workload for teaching.

Furthermore, PBL and eLearning (Figure 6-7) were grey areas for the participants because there are no programmes that have been fully implemented on eLearning to present an opportunity for staff to explore deeper understanding. Participants indicated readiness to embrace approaches that will lead to student-centred learning and active learning following discussions. The merits that accrue from adopting eLearning and its challenges were further explored. Setbacks due to the level of security, data integrity, lecturer control of their courses and availability and competences to use IT systems were encountered in the discussions. Recommendations for continuous progressive training and redesigning of curriculum and IT infrastructure for learning in the design process were proposed.

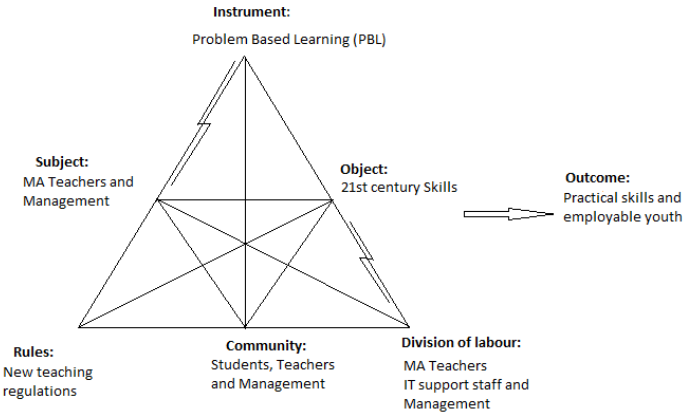

Figure 6-7: The design for developing the practical skills of the learners through PBL.

There were notably some tensions on the division of labour, as I indicated earlier, and some staff argued for retaining their courses and teaching alone, even in the subsequent new curriculums. The level of integration of PBL in the curriculum was contested with arguments that PBL will require more space, will increase staff workload in supervision and will demand better library facilities with adequate physical resources and electronic books (eBooks). As shown in Figure 6-7, PBL necessitates a slow but systematic integration in the curriculum because the teachers themselves need further training and orientation with the pedagogical approach to be more knowledgeable and become more confident to deliver their courses.

The tensions, as presented in Figure 6-7, allowed for discussions about new challenges with technology integration. Some proposals from the IT department members recommended available technologies that can be adopted as part of a pilot project along with BOYD. These technologies were LMSs based experiences at other universities in Uganda and within East Africa. A typical example here was drawn from Maseno University in Kenya, which has also been a partner in the current project and has succeeded in achieving its goal of establishing an eCampus. The eCampus at Maseno runs programmes from all faculties and departments for on campus students and also purely online courses for external students within the region. This is seen as a role model in the region that can provide the staff with a scaffolding role. There are other universities, such as the Virtual University of Uganda, and Makerere and UCU were also mentioned as championing eLearning. Thus, Gulu University can draw on some of the experiences of these institutions.

In discussing technology alternatives, teachers emphasised how they will need to be supported to use the LMS, given the fact that there are few IT support staff and they

are often very busy. They argued that introducing the LMS should come in phases with first phase being identifying teacher champions for a subject or course unit taught in a semester. Defining roles in team teaching based on interest and shared competencies and supervision becomes an important ingredient of this arrangement for teacher champions. This is similar to the case of IT support where an IT support staff is mandated to support users based on their competencies, thus creating a category of users based on current level of competencies in ICT and use of eLearning. Here, it was noted that users, such as teachers and students, have diverse IT support needs ranging from hardware to software and soft skills. Figure 6-8 illustrates these tensions within the implementation process. Teachers are mandated to form groups based on their level of competencies, identify courses that they want to pilot with eLearning, allocate time for interaction with the IT support and bring their computers, while the IT staff are to identify needed technologies and modules that can get the teachers started, make timetables to meet with these teachers, design of the eLearning environment, report on progress and identify new requirements in the process.

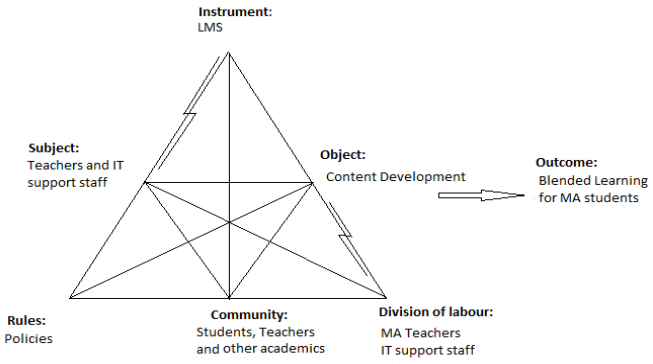

Figure 6-8: Tensions in blended learning and division of labour.

Generally, infrastructure for learning is discussed here as a mixture of ICT and lecture spaces that relates to infrastructure as physical and organizational structures needed for the operation of a system. It therefore also involves curriculum, policies and skilled technical staff that can train others in eLearning. However, this understanding of infrastructure is limited to physical artefacts. It can be noted that there are some contradictions in defining the roles of different stakeholders, especially the technical staff and lecturers because some lecturers seem to think that their roles will be taken over by the technical staff. Another is that of identifying what one can actually do with IT to enhance teaching and learning, instead of assuming that it can do all. The terms eLearning, networked learning, blended learning and technology-enhanced learning are mixed here but all would be taken to mean blended learning in the case of Gulu University.

Summary

The FW enabled participants to be open-minded, learn about innovative pedagogies, and come to appreciate the importance of blended learning within the Gulu University context, so they worked as a team to drive the agenda further. Moreover, they were able to state that there are many positive aspects of the FW method, which include strengthening planning, democratic values, creativity, reflection and active involvement of participants in the process from the very beginning. Participants also emphasised the need for critical and positive thinking to address challenges of learning in Uganda.

6.2.1.4 Analysis of the Workshop Findings

The method

The workshop method was deemed appropriate by participants because they actively contributed to the discussions. While this was true for many, the idea of having control of the situation was so crucial to the structure that participation in workshops had to be directed. A participant noted that the method had some weaknesses in allowing people to make 'wild assumptions that needed a very experienced facilitator to control otherwise it could be difficult to make implementation possible'. The comment was based on activities done in the vision phase where participants were at liberty to express their wishful thinking. It indicated the lack of democratic values which was not what the workshop was intended to address. Overall, however, the general impression was that participants learnt to critique their own situations and envision possible solutions; as one stated it, 'I do not have any dislike because I learnt how to state the actual situation, develop a vision and work toward achieving the vision. It has also strengthened my problem-solving skills'. Another added that 'activities in groups promote critical thinking'.

Perspectives involving critical thinking are not always popular because, in the knowledge transmission environment, they are not a factor that supports the teacher centred approach in the current system. However, the promotion of critical thinking is a welcome idea to the teachers as it can help to improve teaching and research.

The workshop emphasised the need to have students participate as stakeholders, thus making the discussion complete and interesting to all. The students are users of the final product of the design; thus, they should have a hand in the design of their work environment, even when they are naïve about university systems. The programme for orientation of students is proper but only if it is well executed. In many university activities relating to pedagogical training, students are rarely involved simply because they are sometimes thought of as clients rather than stakeholders. Their inclusion will ensure that the outcome will not only inform implementation strategies of eLearning

and PBL but augment the university's strategic planning in its efforts to create a student-centred environment.

PBL

The FW presented at least three models of PBL implementation based on the different universities. There were primarily two interpretations of PBL which could also be seen in the data. The PBL model is also called the problem and project-based model or the Aalborg model (it is practiced in social sciences, humanities, mathematics and engineering departments at Aalborg University) and it is similar to the PBL model that is practiced at McMaster University in its Health Science Department (Kolmos, 2009). The Aalborg model is closely related to the social constructivist approach as the McMaster model is to the constructivist approach. The learning principles formulated in these two separate models are similar (Kolmos, 2009). The Aalborg model is where the practice has little control on students' choices leading to more engagement with the public and private sector. The illustration shown Figure 6-3a is a simple representation that attests to the Aalborg model where a university is situated in a suprasystem of problems or projects that relates to community concerns. The participants in their presentation saw PBL pedagogy as means to make students practice knowledge and develop skills in research in the context of real societal needs. In the end, this would improve the quality of learning for the students, as noted by Kolmos (2009). This, they argued, would increase university visibility and relevance to the local community where it is situated, while at the same time, increasing peer reviewed publications from the university. This is very much in line with university motto 'For community transformation', which was pointed out by one of the participants. However, the McMaster model is more controlled by blocks with predefined themes that teachers have to prepare prior to courses for students to work on (Kolmos, 2009). One of the participants attempted to disagree by asking the audience how PBL can be implemented in large classes (undergraduate class of 300 students) without control. This was seen as an attempt to adopt the constructivist model so that the teacher could manage the workload that this pedagogical approach would present. In the case of Makerere, Kiguli-Malwade et al. (2006) noted that PBL would require more human resources in response to the heavy workload. This teacher thus agreed with the McMaster model in that there could be some level of control by the teacher in the learning process. However, in the workshop, the latter model was more popular based on additional views that the level of staffing in departments at the university was limited so there would already be a heavy workload.

Pedagogical issues always generate debate amongst the teachers. However, all the participants had apparently been culturally and professionally trained as knowledge transmitters giving them autonomy of the knowledge based on the country's education system. Uganda follows the traditional British education system where the teacher delivers learning through lectures upon which an examination is set. This essentially means that what the teacher has taught is what the students need to know at that

moment in time. It is geared toward passing exams other than understanding and applying the knowledge to everyday situations. This system of education, in part, is the reason that graduates at all levels are job seekers – searching for white-collar jobs. Graduate employability is a serious problem for higher education (Ngoma & Ntale, 2016) and the country in the twenty-first century. This agrees with participants' view about adopting the PBL approach so the needed skills are learnt during the years of university study. To change the system, there are rules and regulations that the university needs to follow, starting at local to national levels. As the participants indicated, one regulation is that the implementation is only feasible in a new curriculum that must undergo the due process of approvals internally and accreditation nationally. The need for competent staff to have appropriate resource allocation is essential for approval. Also, all teachers experienced a teacher-centred approach during their time of studies at high schools and at universities, so they are very comfortable with the current system despite its shortcomings. They are trained to impart knowledge to the learners in a relatively controlled environment. For example, in the critique phase, participants noted that students in large classes rarely if at all are involved in collaborative research projects during their years of training because teachers give assignments, more or less, solely to test knowledge. This results in the graduates having to face enormous challenges with employers (Ngoma & Ntale, 2016) because they cannot defend their credentials on a practical level. In many university programmes, there is an opportunity for students to have an industrial placement offer after the second year and a final project in which they can showcase their ability (competencies, knowledge and skills) to work independently. However, amidst the normally very busy semester and normal time constraints, it is nearly impossible for the teachers to measure quality and effectively describe this in their student reports. Also, when we consider the large student–staff ratio, this makes the situation even more frustrating.

These approvals of PBL should be seen as a great move to improve student learning, community engagement and outreach. However, participants complained of the level of readiness of staff and the university to implement PBL programmes. The teachers noted the inability to teach something in which one is not well grounded, especially with methods employing PBL pedagogy. These teachers expressed the need for training to develop new programmes and skills to deliver their course content. More workshops and practical training on specific principles, such as how to design and organise content in PBL, are therefore recommended.

ICT and blended learning

Historically, the university has hired teachers to deliver in programmes at its three satellite campuses, and this has been very challenging in terms of obtaining enough staff. Thus, the dawn of the use of technology was seen as a great solution to delivering more lectures and cutting costs of hiring teacher. However, the participants' (teachers') perception of technology-enhanced learning is more about providing

greater access to education to the citizens without the barriers of distance. To attain this goal, an LMS such as Moodle presents a pedagogically organised, ready to use environment for institutions introducing ICT and blended learning. This became the foundation to to argue for introduction of new pedagogies and using of Moodle LMS.

6.2.2. COED WORKSHOP: DESIGNING FOR BLENDED LEARNING

This research method affords the researcher with the ability to conduct a study of a phenomenon in a real-life context, thus investigating questions like how and why of the study (Bjorner, 2016) during the workshops. Participants are in position to make informed decisions as they identify and organise learning around available resources. The information obtained in the realization phase of the FW formed the basis for the CoED workshop.

6.2.2.1 The CoED Workshop

The workshop was organised around blended learning and PBL. This workshop involved over 30 participants, some of whom had attended the FW while others had missed that workshop. The number of participants was large but since the method was being used for the same time with the participants, the facilitators had to mix short presentations with group work. This technique was very effective, and in the end, all those views and experiences came through in the plenary presentations. There were facilitators from Maseno (2) and Aalborg University who were also teachers and experts in PBL and eLearning. This workshop lasted about five hours in total and was divided in three phases. Participants were sorted into five groups of six to eight members at the start of the workshop.

First phase

Like the FW method, the CoED method was also new to the participants. The phases therefore thoroughly outlined the method, allowing for a brief presentation focusing on the eLearning design by the facilitators to establish the groundwork for the design activity. This presentation had two parts: a) the pedagogical perspective with a focus on the traditional teacher-centred approach compared with PBL in the case of Gulu University, with added experiences from Aalborg, and b) a focus on eLearning (here referred to as blended learning because of the outcome of the FW that emphasised a slow migration to eLearning and fully online delivery) with experiences from establishing the eCampus at Maseno University in Kenya. Participants interacted with the facilitators and established the common understanding and terminologies and set the scope of the workshop as a prerequisite to the design activity.

Second phase

Using the Aalborg University online CoED method value card generator, alternative value statements were generated and printed in three colours for easy sorting. According to Ryberg et al. (2015), the card generator produces a document in rich text format (rtf) with designed cards and header. These cards are in three categories for the user to choose either activities, resources or infrastructure. Each of the categories is described in detail for ease of use. The system then allows users to create as many cards as they would like to print depending on the workshop requirements. Participants were divided into groups of 6 to 8 people per group, making up to five groups. The diversity of the participants was factored into the group formation so that fruitful discussions and reflections could occur and be reported.

In this phase, the value cards that were printed depicted value statements. such 'Linking academic and business', 'Learning to learn', 'Critical thinking', 'Problem formulation', 'Collaborative', 'Self-directed learning', 'Increase chances for finding a job', 'The university as agent for local and regional change', 'Teamwork' etc. These value cards and statements formed the pack from which the participants could choose the values and principles to guide the design (Ryberg et al., 2015). This allowed participants to reflect on the courses that they taught by choosing a course and discussing its goal, the target group and the content in relation to the PBL and blended learning. This allowed participants to discuss and reflect on their educational and pedagogical principles (Ryberg et al., 2015). Based on participants' experiences and the niche for each programme they taught at the university, empty cards were used to allow them to write the name of their 'target group'. It was not possible to determine the target group at the time of the workshop, so the facilitators printed extra cards (blank) to allow the groups to independently determine the programme and course unit and to discuss their design. Figure 6-9 shows the results from that activity from one group.

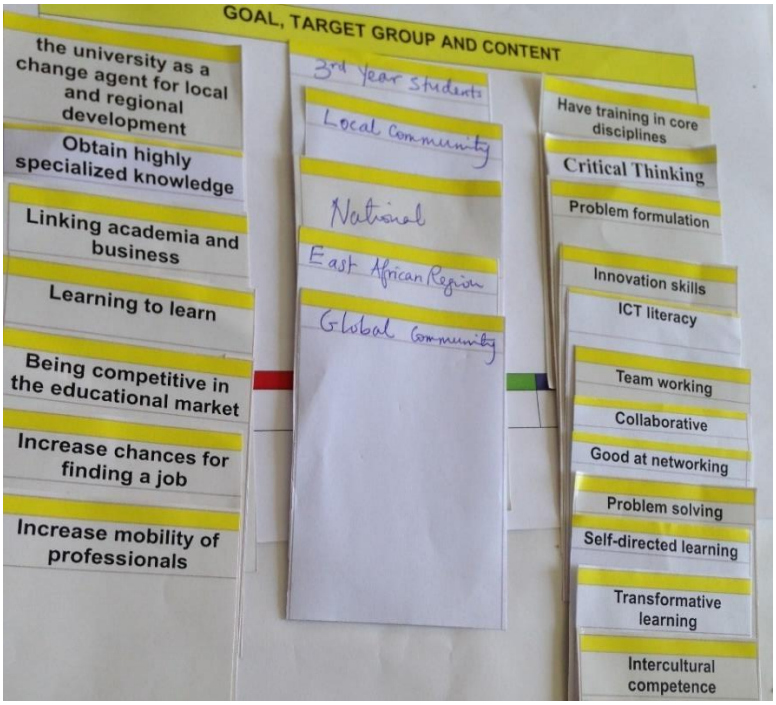

Figure 6-9: Designing for blended learning.

One can see that the groups chose their preferred course and organised their discussions around it. This kept the focus on content of the course and how to deliver it to the learners.

Third phase

This phase was intended to help the participants develop a more concrete design based on three categories defined by the methodology to distinguish amongst learning resources, learning activities, and infrastructure (Ryberg et al., 2015). To achieve the goal of the phase, each group held a discussion in which they used the cards to show how they would achieve their goals by categorising the cards into required activities, resources and infrastructure. The courses chosen were those in existing programmes, so the groups attempted to redesign their course outlines and course activities so they would align with blended learning and PBL. The value statements were carefully selected based on the outcome of the FW in addition to the choice of the content based on the second phase of the design workshop to include key terms such as ‘eLearning’, ‘Collaboration’, ‘Problem formulation’, ‘Blended learning’, ‘Open education resources’, ‘Internet’, ‘Lecture halls’, ‘Teacher’, ‘Facilitator’, ‘PC’, ‘Planning’, ‘Assessment’ and ‘Library resources’, including some extra cards for topics that they felt were missing (Ryberg et al., 2015). These cards presented a mix of statements

containing resources, activities and infrastructure. Participants discussed categorisation of these cards based on their understanding of and reflection on their practice. Resources identified were chats, teachers, library resources, wikis etc.; the learning activities identified were case study, collaboration, supervision, groupwork etc.; and infrastructures consisted of the internet, personal computer (PC), video conferencing, Wi-Fi, LMSs, Skype etc., which were all related to those reported in Ryberg et al. In this activity, the identification of resources and infrastructure was very important as part of structuring conversation about eLearning. Figure 6-10 shows the categorisation and visualisation of one of the groups.

Figure 6-10: Categorisation of services and infrastructure.

This activity engaged participants in the design and, more so, enabled them to reflect on and visualise the relationship amongst resources, activities, pedagogical intentions and the required IT infrastructure (Ryberg et al., 2015). Also, this required them to prioritise resources and infrastructure that would be the most important in the earlier stages of implementation. The activity format then allowed participants time to structure their discussion about blended learning (eLearning) and the required infrastructure to facilitate such a new direction. The participants prioritised

infrastructure as one of their major challenges in the adoption of blended learning. A participant decried the state of the infrastructure in the university as generally very poor: 'How can we talk about eLearning when we do not even have computers?' This emphasised that the availability of computers for the staff and students at the university is a prerequisite for eLearning. Also, the need to connect satellite campuses was noted to be the main driver for eLearning, as there were complaints about the cost of facilitating staff to deliver the same material at all these campuses. A participant from the faculty of Education and Humanities stressed this: 'We need to start using video conferencing with our satellite campuses, especially Kitgum that has few students'. At the start of the project, the University had three satellite campuses (Kitgum, Lira and Hoima). However, within the same period, Lira constituent college became an independent university that is now called Lira University.

A participant esponded to the need to use technology-enhanced learning as a possible solution for the rising administration cost of Kitgum and other campuses. Using the case presented above, it was evident how the participants tried to visualise which resources could form part of a learning situation which could be facilitated by IT.

Participants in one of the plenary sessions looked at internal issues of library (space and eLibrary), lecture space, curriculum, internet availability, policies, bandwidth increase, computers availability, financial resources, staff capacity (both academic and support), LMS and organisation structure as important in achieving the goal presented by all groups – to implement eLearning. Infrastructure was an overarching issue with emphasis on IT infrastructure since it forms the basis upon which all these IT systems are implemented. An inclusive approach to build and use the infrastructure was important to discuss in addition to what experts from Maseno made available through sharing their success stories and acceptance to scaffold Gulu in the same process.

6.2.3. FOCUS GROUP DISCUSSION: USER AND TECHNICAL PERSPECTIVES

A workshop with a specific focus on the IT infrastructure from sociotechnical, sociocultural and user perspectives was organised. The workshop aim was to evaluate the prototype LMS and its affordance of the didactic principles, user experiences and technical perspectives.

In this study, the research was primarily driven by pragmatism in the belief that infrastructure for learning affects the real-world practice of a problem situation (Mackenzie & Knipe, 2006). But, it was also transformative in nature because of the larger BSU project upon which this research was associated. It is important to emphasise that the theoretical lens here was based on a more radical conceptualization of change leading to transformation based on Engeström's AT (Avis, 2007). We took as a point of departure the fact that infrastructures are built to meet human needs, and

they are therefore used to enhance human practices, which in the end, shapes these infrastructures. Understanding human practices and culture is such an important perspective in understanding infrastructure. The study therefore explored the constructivism and pragmatism in understanding and explaining phenomena surrounding the infrastructure for learning. It remains however a situated problem centred around designing and developing infrastructures for learning.

This research underwent a process in which the introduction of PBL and e-learning was incrementally presented to the teachers of the faculties of Education and Humanities and Business and Development Studies and the university administration. This introduction of the two pedagogical approaches necessitated the investigation of infrastructure for learning in the same institution for both the faculty of Education and Humanities and that of Business and Development Studies. Sequentially, the learning process transformed the intentions and activities of the pedagogical models to reach a better understanding of their application to higher education. From the beginning, the project followed an experiential learning theory. We used AT, upon which the expansive learning theory was built, to clearly understand the interactions leading to design outcomes and feedback from stakeholders. By taking the LMS as a designed artefact and incorporating the principles of AT, we were able to create new directions based on a model of artefact-mediated and object-oriented action (Engerström, 1987) in understanding artefact use by the user. The CHAT focuses on the processes where the subject acquires some identifiable skill or knowledge, such that a lasting change in the subject can be observed with the assumption that knowledge and skills are stable and well defined by a teacher (Engeström, 2001). This was not the case in our study because the people and organisations were continually learning, so it became more important to learn new activities in order to transform ourselves and the organisation. Expansive learning theory was built to handle some of these challenges (Engeström 2001) and, in its early stages, was developed and used within the psychology of learning, cognition and child development. However, it later expanded into different fields of study and became important in understanding development of work activities in organizations and implementation of new cultural tools such as in computer technologies (Kaptelinin & Nardi, 2012). Thus, AT is essentially based on the mediation of human action, according to some cultural theorists.

6.2.3.1 Sociocultural Perspective

The sociocultural perspective is an umbrella term that embraces cultural psychology, CHAT and situated learning (Guribye, 2005) which are individually unique fields. It addresses some of the issues that link human actions and technology. In CHAT, Engeström's (1987) systemic properties of activity systems are emphasised. These attributes of the activity system are the role of interaction relating the subject and the community which somehow defines the social norms, the role of artefacts being central to the sociocultural perspective (Guribye, 2005), and the division of labour. As artefacts are central to the sociocultural perspective, it is also the core of the

infrastructure for learning. However, infrastructure is a broad concept that encompasses many things that cannot be thoroughly reviewed here.

The social science assumption posits infrastructure as a 'war machine' in non-societal development (Virilio, 1986, as cited in Kellner, 2009; Virilio & Lotringer, 1983). The sociocultural environment is where instructors and users interact with the technology for teaching and learning. Technology in itself is not one-sided as is often assumed, but involves interaction and usage. A participant noted that 'in order to understand ICT, we need to look beyond what we see rather than as objects but as subjects if we are to bring some modules on board'.

This same participant suggested that ICT is subjective rather than being only objective. He argued that it affects the way we work, how we work and what we do as teachers at the university. He emphasised that understanding ICT extends to its use as an environment for teaching and learning. This relates to how Moodle, as an infrastructure for learning, can be used to handle course modules and how teachers can use it to engage with the infrastructure.

It was also noted that computers are not just artefacts that people use to enhance their work but a subject with which instructors interact to deliver education services. Participant asserted that 'ICT is not only an object as seen from a technical perspective but rather as a subject because it transforms our behaviour and activities. We can teach using computers whereby computers become a subject with which instructors interact'.

Another important aspect of improving teaching and learning is to properly implement technical infrastructure with the needed capabilities. Some of the capabilities are to support student-centred learning rather than traditional teacher-centred learning. These could be understood as a means to partly address some of the PBL principles along with the twenty-first century skills. The infrastructure therefore is seen as a medium that enables implementation of all these activities. One participant put it this way: 'When the infrastructure is properly enacted, teaching is enhanced. The practice of teaching and learning is therefore more inclusive, and student-centred rather than teacher-centred education is achieved'.

The participants noted that all these sociocultural issues should be aligned with the institutional vision, mission and objectives. In this case, it would mean to keep a focus on, for example, the university's mission which is 'To provide access to higher education, research and conduct quality professional training for the delivery of appropriate services directed toward community transformation and conservation of biodiversity'.

To support the institutional objectives, the infrastructure design and use have to be clearly defined in the approved institution policies and procedures. Acquisition of

resources to build infrastructure should follow from the design and be in conformity with the policies. A participant noted that there are no policies and procedures for ICT use which has resulted in an ineffective implementation process for ICT. He said that 'at Gulu University we have the lab, but if we don't have enactment or procedure to use ICT, then it is rendered useless'.

This simply implies that policies are very crucial to the use of ICT as infrastructure for learning. Since there are none currently, the participant seemed to suggest that it is time such policies are written and approved by the university. In the same submission, the participant added that motivation of the users to use the infrastructure is an important part of enactment of these rules and regulations. In addition to motivation, building capacity of users within the infrastructure could not be overemphasised as a need. One participant noted that "Enactment is the ability and/or motivation for building the capacity of users within the infrastructure'. Another stated that "This should also be in line with detecting the readiness of usage and deployment in enhancing learning'.

The use of a participatory approach to capacity building of users (i.e. staff) needs to be built within the infrastructure. To align this to the work of teaching and learning, it was indicated in the submission questioning, staff readiness to use technology to enhance learning is essential. Readiness could be explored as an extension of this research because the attributes of readiness could not be exhaustively addressed in this research; however, it is certainly an important part of ensuring sustainable use of the infrastructure.

It is important to recall that Gulu University is a typical case of a resource constrained environment, as I discussed earlier in Chapter 1 of this dissertation. Within this constrained environment, there are mixed attitudes and perceptions of users toward technology adoption that should be explored further. Participants' training backgrounds literally have produced very few who are knowledgeable enough in ICT use in higher education. Many of them are however people who are technology enthusiasts with positive attitudes and perceptions about using ICT in teaching and learning. However, the use of technology being a new phenomenon in higher education that is based on the traditional teacher-centred approach and all staff having been trained in the same way has slowed the overall progress of adoption. Issues of skill and competencies have resulted into some resistance to the would-be champions in advancing the notion of technology-enhanced learning. A participant indicated that 'from a sociocultural point of view, there is always resistance. ICT inconsistency has constrained a number of deliberations and thus the need for alternatives'.

Staff resistance is implied here as something not new based on sociocultural viewpoints of academics about the adoption of ICT in their work. A workshop participant pointed out inconsistencies (availability and reliability) in the current ICTs at the university and drew the conclusion that there needed to be an alternative

approach. He supported his contribution by explaining that: ‘In other words, some individuals cannot tolerate failures in terms of availability, support, and thereby switch back to the manual system of operations’.

This would mean the consequences of the lack of reliability, availability and IT support for the academic staff engages a reverse gear leading to some form of resistance. This resistance is to some degree caused by frustration brought about by both the human and technology infrastructure responding to user requirements.

Participants argued that IT in itself requires a closer look because there are some staff that can easily be excluded if IT is adopted and becomes mandatory sooner than later. Staff have differing levels of use and specialisation. So, for some, there is a need to continue with our current approach, while others could switch with ease. Background training of these staff may also present alternative perspectives that need to be considered as implementation of some of these ideas progresses. He also commented that ‘On the other hand, technology is sometimes viewed as a delimiting factor for teaching and learning as some categories will be excluded, especially where some of the staff are considered ICT illiterate’.

The ICT literacy of staff is seen here as a factor that impacts the effective use of IT for teaching and learning. Participants introduced the concept of exclusion of other staff through ICT as a delimiting factor when considering ICT literacy of the staff.

Participants seemed to rely on their support and skills, but one made it clear that an important attribute to adoption is to make users get used to the services through constantly available services. He emphasised that availability of a given technology may also strongly influence attitudes, and he stated that ‘users need availability, the presence of a service when and how the user wants it. The challenge for us is that availability and reliability of a service normally influence our attitude to adopt the technology’.

This could in itself be very contradictory because availability is limited by infrastructure and the capacity to constantly pay for the services, such as bandwidth and software. It could also be that staff motivation and skills to use the services generate further demand on the services, leading to prioritisation to make available ICT services and support. This submission could also be speculative based on the status of the ICT services and infrastructure at the university, or rather based on published research material from other institutions in similar situations. The submission also indicated that the participant was arguing for a combination of availability and reliability of the services that influence attitudes toward adopting technology. Reliability, in this case, was being considered a function of the ICT infrastructure being able to sustain user requests consistently. However, across all these submissions, we saw working infrastructure at the centre, thus combining electricity, internet access, bandwidth, reliability and availability as strongly affecting

adoption which is in agreement with Munguatosha et al. (2011). This is a sociotechnical issue rather than a sociocultural one based on the nature and the direction it takes toward IT infrastructure.

Availability is also a motivating factor for primary stakeholders in that both students and lecturers are more willing to work when there are services such as the internet running consistently. Availability of a service could be understood as having the potential to positively affect its use. To account for availability, for example, the IT unit decided, in consultation with colleagues from Maseno University, to host Moodle in another country where there is stable infrastructure. This was done to allow users access to it independent of the current infrastructure at the university. One participant noted that 'Our LMS is hosted somewhere in the UK because we wanted to ensure that the services from it are available to the users as and when required'. This arrangement allowed for services to run for 24 months without interruption. Members were able to explore the system functionality, and many workshops were implemented partly through the LMS to keep it in constant use.

There could be other factors, such as efficiency of the service, but the participants maintained that availability was the most essential in implementing infrastructure for learning at the university. Examples were particularly given about the availability of services, such as internet access and the LMS, as important to the infrastructure for learning. Generally, it can be acceptable that users build the culture of use of the infrastructure for as long as it is available to them. This has a direct implication about design because it allows for a design of use that could be a repetitive process of design with user participation. This, in the process, keeps all stakeholders abreast of infrastructure shortcomings that are then readily reported.

Staff frustration is felt when users begin to provide alternative solutions to what is available even though they participated in planning and designing that solution. Participants referred to frequent cases where staff have decided to use social media as a platform for learning. A participant suggested that 'resistance is seen when users leave out what was planned and improvise an alternative which was not earlier on in the plan.' This move to such alternative use of technology could be attributed to the strength of social media amongst students.

In modern societies, technology adoption is now seen from a symbolic and transformative point of view. Participants intimated that some people use technology as indicators of modernity. These are seen in the case when students argue that, at this time in society, everyone has to be on social media. And, to be on social media necessitates that one has to have a smartphone. The smartphone technology offers enormous functions, but many of these are never used or even known to the owners. The acquisition of such an artefact is based on symbolism for modernity, which is a common phenomenon even to staff. In addition, another participant indicated in his

presentation that ‘many people and societies adopt technology as symbolic and transformative’.

In addition, adoption of technology is seen as transformative. Adoption of such technologies indicates that such persons or institutions are transformed to a modern status. However, he continued to assert that this is more applicable to individuals in our society and is slowly spreading to organisations: ‘Individuals and societies are now more adapting to organizations and groups that embrace advancement in technology’.

Organisations of the magnitude of universities and corporations are slowly adopting advanced technologies to manage their business processes as required by government. Governments are at the centre of using these advanced technologies to deliver services through its departments. Services such as tax collection, financial management, information services to the citizens, training and supervision have all integrated these new technologies.

6.2.3.2 Sociotechnical Perspective

The sociotechnical perspective in this thesis looks at how the interaction between humans and technology shapes the design, requirements and adaption of these technologies to teaching and learning. This should in the end lead to an acceptable balance between the human and technical components because of continued negotiation with individuals and user groups (Mumford, 1983). The understanding of how social and organisational factors affect how IT systems are used is as important as understanding the technical requirements themselves (Baxter & Sommerville, 2011). Systems development has followed technical perspectives based on the expert-led system development delivering solutions that have suffered from the lack of user acceptability. This does not mean that the technical quality is compromised but that systems are very subjective and do not afford the use for which they were designed. The systems’ lack of flexibility to embrace new and unpredictable user requirements could lead to the systems becoming obsolete with less support for intellectual growth (Mumford, 2006) of the human infrastructure during the system life cycle. The use of the sociotechnical systems approach in systems development have proven to result in higher levels of user acceptance as well as customer satisfaction (Baxter & Sommerville, 2011).

The participants in their discussion noted that the linking of technical systems with social organizational characteristics should mutually promote designs that alter technology to achieve a desired and humane fit. This, in one way, is an attempt to holistically design IT systems to take care of human needs as much as the design can accommodate and, in another way, to represent organisational work processes and culture. In order to make the design and implementation of IT systems align with organisation settings, such a design should accommodate the goals of the organisation.

The choice of technology should therefore be driven by the organisation's vision, goal and objectives to support teaching and learning. In the case of higher education, IT should be designed to respond to the needs of teaching and learning, such as content creation and sharing, in its search to facilitate online learning. According to one of the participants' 'Technology for learning in this case can be used to find, create and share contents and to facilitate in-class and virtual activities'.

The need to share content and provide real time in-class and virtual activities was proposed by a stakeholder as the future goal of Gulu University. The use of technology for in higher education is progressively taking shape in developing countries. We see ICT being used for access to content, digital materials, communication, interaction and collaboration (Munguatosha, Muyinda, & Lubega, 2011). The participants observed that technology cannot be ignored in transforming education. The important thing is how to integrate this technology in a manner that will minimise some of the documented setbacks such as job loss, high cost of investment and lack of sustainability. These would need planning and the use of PD to adequately address humane democratic values. A participant noted that 'it's no longer defensible if it ever was to ignore the involvement of new technology in reshaping of educational practices, expectations, assumptions and relationships'.

In respect to this assertion, current educational practices, assumptions, and expectations will require revisiting and adopting ICT to improve the practice, relationships, people's expectations and assumption about higher education outputs. Currently, there are many technologies designed to support different levels of learning as described in Bloom's taxonomy. This taxonomy is composed of six categories: knowledge, comprehension, application, analysis, synthesis and evaluation (Lampinen & Arnal, 2009). Some technologies have attempted to integrate all these and more current expectations about instructing students. Some of these expectations could include collaboration, teamwork, leadership and skills.

It was however noted that, to deliver the twenty-first century skills, using the current traditional teacher-centred approach may not yield any tangible results. The employment environment demands so much from the students that the current pedagogy and institutional settings cannot provide what they need. The use of technology and revisiting the pedagogical approach to a student-centred approach would offer a way for graduates to meet expectations of employers or for graduates to create new jobs. One participant stated this: 'The traditional teacher-centered learning is not able to drive the current agenda so the university needs to adopt technology aided learning to help achieve our goals and objectives in the twenty-first century'.

It is expected that new pedagogy such as PBL will in practice lead to developing students all-round skills to improve their innovativeness and employability. This is a challenging case in resource constrained settings as those in many, if not all, developing countries.

The complexity of IT adoption in higher education is associated with access to technology, socio-economic background, perceived usefulness and user specialization. Access to technology means having the technology available for use as and when needed. This concept of access could also be related to the socio-economic capacity and user ability to acquire that technology or artefact. However, the perceived use of the technology describes the sociotechnical attributes of the technology and, thus, can promote the need to acquire it.

A closer look at teaching and learning processes, at an operational level of complexity, could also refer to the content developed by the teachers/facilitators/instructors to make use of the available technology. This relates to the need for those involved in instruction design and IT infrastructure capability to organise the knowledge for easy consumption of the learners. The participants observations were reminders for institutions that there is need for adequate human infrastructure ready to support the teachers in their efforts to integrate technology into their work. One participant argued that:

> In many instances we find that institutions adopt certain technologies without proper knowledge by the instructors. For example, at Gulu University MOODLE application software was adopted before the institution as a whole was not ready to implement it properly.

This comment is a contradiction to what other participants in the workshops described earlier. A systematic integration of technology to the teaching and learning was recommended, but this manager seemed to be particularly not in support of the progressive implementation. However, I would argue that he seemed to be advocating for readiness of all policy documents, complete IT infrastructure design and implementation, employment of technical staff and other necessary procedures as a prerequisite to implementation. This view, being contrary to the position of the PD and systemic adoption based on programme, was not a convincing argument that the entire university needed to get ready before the implementation started. This led to the staff moving in contradictory directions (Mumford, 2006). However, the common position was reached as the IT support gave a detailed and documented process followed by decision on the use of LMS (Moodle) to redesign and improve the current infrastructure to accommodate the staff needs.

The capacity of the current infrastructure was noted as inadequate and as presenting the biggest challenge to adoption. The argument was contradictory in that this participant emphasised that at the implementation stage, staff motivation was more important than availability. One participant argued that ‘the capacity of the infrastructure is the biggest challenge, but the implementation requires motivation more than availability of the infrastructure’.

This stakeholder submission was not concrete as to the details of what was meant by implementation in relation to motivation and availability. The argument that motivation is more important than availability needs further substantiation. Motivation has a broad connotation because someone could be talking about intrinsic or extrinsic motivation making the submission difficult to explain in relation to the design and implementation of the IT infrastructure.

In many ICT infrastructure constrained environments, such as those included in the baseline study, we found that very good ICT policies existed, but execution was the challenge. The administrations would not like to admit this, but reflecting on the cases of Makerere and Muni, one can see that this important issue is at the core of the matter. At the structural level, for the case of Gulu University, the proposed ICT management structure that should support ICT needs is not being implemented or, rather, approved so that the human infrastructure can be addressed though employment of some skilled IT professionals to manage and maintain results of the current efforts. There is clearly a lack of operationalisation of the existing structures, thus constricting the whole ICT system and its independence to account for service provision to the university community.

A participant reported that the university IT unit is not currently represented in the institutional structure. The importance of locating ICT in the institutional structure is paramount to the success of the implementation of any design. The university has delayed this proposal for over four years, and it has made the functioning of the unit difficult. These unclear circumstances have been coupled with mixed reporting, thus making administration of the unit nearly impossible. Further, a participant asserted that ‘there is need for the ICT to have a home, the need to know where ICT can be housed, the need to create a directorate of ICT of its own as it is in other universities.

This comment is a recommendation that is based on experience from other institutions with similar conditions or even those that just started after Gulu and have all these setups already in place and working effectively. The participant decried the state of the ICT connectivity and services at the university: ‘The campus wide connectivity and services offered on the current infrastructure are poor’. Moreover, a key recommendation for Gulu University, according to a workshop participant, is that ‘in order to effectively implement the ICT in learning programs, there is a need to put in place a functioning department/unit of ICT with the power relations issues and structures streamlined’.

The operations of the IT unit are based on the level of independence within the current structure. The statement suggested that there is a power struggle that is leading to the unit failing to attain an autonomous status. The power relationships at the moment are not clear as the submission did not state where the contradictions exist but only intimates about a mixed structure that needs reorganisation. Participants also noted the importance of the IT unit being autonomous with some alluding to a draft proposal

that was presented to some committees to scrutinise. Additionally, it was asserted that the ICT is not ranked at top of the university agenda, and yet there is no way they can run an institution of higher learning without adopting the use of ICT. He argued that 'ICT should be autonomous although currently, it is not a priority at the institution'.

The issue of prioritisation of ICT at the university seems to portray the frustration of the staff or somewhat justify the resilience of the staff to adopt it. This is actually not conclusive at the moment but should be further explored.

Sociocultural and sociotechnical issues are real and need to be integrated as part of the system design and implementation so that change can be realised. These are some of the challenges one can attribute to the lack of an interdisciplinarity vision of professional work within academia. Universities are known for the bureaucratic nature of their work which overlooks the need for sociocultural and sociotechnical importance at the design of IT infrastructure. Indeed, ICT is always viewed solely as being technical and that anything about it has to be dealt with from the technical perspective.

6.2.3.3 Technical Perspectives

ITC-supported learning practices have become an important part of university education (Nyvang & Bygholm, 2012). This integration of technology in university education is steadily transforming the sector and opening it up for access. The development in smaller institutions such as Gulu University comes with many technical issues. Infrastructure development has been primarily an important pathway to realisation of the use of ICT in education. At the national level, the national fibre backbone is nearly complete, and all major towns in Uganda are connected (NITA-U, 2015). The last final connection to Gulu University is complete and stable. IT infrastructure for learning is improving with emphasis on the hardware and software through development partners and government projects. However, having adequate technical personnel remains a challenge in many institutions that I visited. There are very few staff in the IT department, resulting in work overload. An examples could be drawn from Muni, Busitema and Gulu where a single staff is responsible for many roles. The technical team is responsible for delivering IT services as required by the users. The provision of the services has presented challenges for Gulu because of the lack of approved policy provisions which are an important part of infrastructure for learning.

Participation and stakeholder engagement in the process of design and implementation of the infrastructure for learning specifically was found in this research as highly important in addressing the problem of resource limitation at Gulu University. The introduction of new pedagogical approach based on PBL and eLearning at the university will eventually be a sustainable venture when all stakeholders actively participate in the design and implementation of such a system. The design of the IT

system will then follow the participatory approach, thus strengthening the democratic values of accountability of system capability and limitations to the users. This approach has led to adoption of Moodle as a LMS for the university. This system will enhance blended leaning as recommended by the stakeholders. Also, as I indicated earlier, the university is now running PBL as an eLearning pilot along with traditional teacher-centred pedagogy.

The technical perspective will then follow the design and development of IT infrastructure in respect to the IT unit, its policies and the use of Moodle at Gulu University. The following sections will discuss all these from the standpoints of the user, administration and technical supporters because these infrastructures are integrated within institutional structures and its organisation.

6.2.3.4 Development of Policies

The need to develop policies and frameworks to guide implementation of infrastructures for learning was noted in the discussions. The participants stated that, although these designs were done to guide the implementation, the policies and procedures are lacking the means for stakeholders to enforce them. A recommendation was suggested to the IT unit to draft the required documents and present them for approval through the university organs prior to rollout.

The instruments that needed approval were the ICT policy and other accompanying implementation strategies, user and content development policy and library and plagiarism policies.

6.2.3.5 User and Technical Perspectives

Gulu University opened in 2002 with the functions of teaching and research by both staff and students, as well as community outreach. Infrastructure for learning has been a problem since the inception of the university; however, there are computer laboratories in some faculties and internet services with support from donors and currently support from African Development Bank (AfDB) and BSU. Programmes using blended approaches were also developed as well as some courses using ICT. Attempts have been made to ensure that both staff and students use ICT, and courses such as literacy in ICT are compulsory for some students. However, challenges have been faced in the attempt to use ICT in the service of the university, such as a very limited infrastructure. In fact, NCHE policy states that there should be one computer per 10 students, but available usable computers in the laboratories are few (15 in total) and they cannot accommodate the current number of students. Also, faculties are forced to share the computers and have to negotiate on when to use the laboratories, so accessibility is a problem. Thus, inadequacy of computers was also observed in the discussions:

> Since 2005, the university has never bought any single computers for the laboratories; the available computers were bought by projects under NUFFIC, Uganda Fund and UCC. The university has been relying on external support, although maintenance of these computers should be performed by the university, lack of funds for maintenance has been a problem. We have benefited from maintenance fees paid for trainings by government agencies and NGOs.

The problem of the lack of software is very common; thus, some courses that require such software cannot be taught because the software is unavailable. As one participant stated:

> For instance, in the faculty of Business and Development Studies, it was observed that a course unit in accounting had to be removed from the curriculum because it required installation of a software that the university could not provide to the department.

The Mathematics Department also reported that they tried to take their students to the Department of Computer Science to access and use the single computer laboratory for one course unit, but the laboratory could not allocate time to the students. This was because the schedule was full from the beginning of the semester to the end. This pressure on the computing resources at the main campus has resulted in many internal and external challenges. A participant commented about this problem:

> Internet connectivity is available but very slow. Poor maintenance system, such as the anti-viruses, no routine servicing of computers and yet firms are contracted every year to provide such services, let alone the mere cleaning/dusting of the computers.

The observations also pointed out the internet connection as being very slow. When asked further, the participant indicated that most times they use dongles. So, one can note that at the time of doing this research, even individual staff preferred their own devices as compared with those of the institution. The internet dongles are based on subscription from the telecommunications companies that provide data along with voice. Companies such as Mobile Telecommunications Network (MTN) Uganda, Africel Uganda, Airtel Uganda, Uganda telecommunications and others have provided for a simple portable device that often responds to user problems of availability and location independent of use. The connectivity at the campus is slower than internet cafés in the town and these mobile dongles or routers.

In respect to the concept of BYOD and the argument for its adoption, the internet element of the ICT infrastructure is very important, and its speed and availability is taken seriously by stakeholders. Other sustainability challenges of routine maintenance and antivirus were emphasised. It is difficult to understand why

prequalified firms are not able to offer their services to maintain computers at the university or specifically to the computer laboratory used for teaching and learning.

Staff attitude was discussed at length as participants argued that a good number of staff are still traditional and not willing to change. The change could be facilitated through continuous staff training and scaffolding. However, one workshop member pointed out that 'The Faculty of Science, through the Department of Computer Science used to organise some trainings for staff during lunch break, but very few staff would attend'.

The university has adopted a new infrastructure for learning (Moodle). It is designed, installed and ready, but only few staff are using it. The staff therefore needs constant refresher training and walk-throughs at the beginning of each semester. This training is twofold. Many of the academic staff require training in ICT skills that could be handled by the IT unit in collaboration with the Department of Computer Science (teaching department) with skilled personnel, and the other is in basic troubleshooting. The latter requires skilled staff from the IT unit to handle; however, the infrastructure of the current unit is incapacitated both in numbers and specialised skilled training for its staff. D1 indicated that the IT unit is understaffed and yet they are expected to 'do everything'.

6.2.3.6 Administrative Capacity and Preparedness

The university management has a lot of support for the development of infrastructure for learning and understand that infrastructure for learning is well beyond the traditional notion of being physical space. They note that it spans the horizon into social and cultural issues of the institution and the community. One participant expressed this: 'Infrastructure involves houses, space, tables, computers, attitudes, … and all these are in the strategic plan that one of the purposes is to indicate planning and develop infrastructure for learning in the university'.

The university, through its Department of Planning and Development working with the IT department, has developed a strategic plan. The two departments are in the process of creating structures for the IT department in which infrastructure for learning is incorporated. Thus, the strategic plan will cover all aspects, including ICT, construction, human resources, equipment or machinery and transport equipment. All these are intended to be ways of developing the learning environment. In this regard, it is a concern that the process is however only centred on a few individuals with the necessary expertise. It therefore becomes difficult to account for sociocultural and sociotechnical perspectives in the design if such an approach is not purposively made more inclusive. Based on the contributions of the workshop participants defining what they considered infrastructure and its components, it can be concluded that the sociocultural perspective is obviously lacking.

The IT department has prepared a structure that incorporates the required human resources as part of the planned IT infrastructure. This strategic plan is going through the university organs for approval. This plan, however, challenges the current establishment with its staffing that is overwhelmed with work. Some of the work on the infrastructure does not directly have the needed human resource expertise; thus, there has been an overburden placed of the current staff in attempting to respond to all the technology challenges of the teachers. This kind of workload could highly affect the attitudes of both the IT personnel and users of IT services within the confines of the institution.

Looking at the discussions moving back and forth between ICT infrastructure and PBL pedagogy, one can realise that the question of attitude amongst staff is eroding staff motivation and affecting workflow in the institution. Staff are challenging one another by questioning what is new and where PBL is known to be innovative, as it is claimed to address some of the twenty-first century skills. One participant contributed the idea that 'Attitudes are always pulling us back, e.g. PBL was pulled back by many academics who actually challenge innovation in PBL'.

Some experienced that staff who had known PBL and blended learning from other institutions were sceptical about the success of this at Gulu University. They argued that, because of the lack of resources that are required for the implementation of the pedagogy, it had failed at another institution already. Although this may be true, there was no substantial documented evidence for the claim in the available literature from the institution in question. In all these debates, however, participants agreed with the need for the goodwill and energy given to discussing how design and implementation is based on user needs and involvement.

A participant noted that 'Some people with authority in their domains express their willingness with caution on institutional environment and administrative structures'. Another contended that there are social and political issues with bringing in new ideas, and some staff feel that others cannot initiate change in their domain. In this case, a staff member, who may be teaching in another department or come from the administration, may present ideas that could benefit another academic department directly or indirectly. This phenomenon often occurs because staff travel for conferences seminars, study assignments, meetings etc. Academics and administrators from institutions of higher education should always be open to new ideas and new ways of learning so that we can ably compete locally, regionally and internationally. Reflecting on the institutional culture, a participant preferred to say that 'The minds are not fully prepared to receive new innovations into the institutional culture… and that in many instances instead of critiquing, staff criticise good ideas because it is championed by someone from a different department'.

For example, one participant described his assessment of the situation as follows: 'The idea of PBL was brought by an administrative staff member who had gone on a study

stay in Aalborg, Denmark but was criticised by academics who say it had failed in Makerere University, so it is not good'.

This is contradictory because this staff member thinks that all academic developments are supposed to come from an academic. The criticism is, in this case baseless, as these institutions are different culturally and by the nature of their establishment. The way change is introduced to a community determines whether they embrace it or fail to accept it. Therefore, understanding the cultural orientation of the institution and its social fabric could be major factors to consider while advocating for change. Also, it should be noted here that the staff member who claimed that the case of failure will reoccur could not provide documentary evidence from Makerere on how it failed.

Moreover, considering the efforts taken in introducing the two pedagogical approaches and the need to address employability of the graduates from the institution, this is a contradiction since logically one would expect staff to embrace new ideas instead of destroying them. Notably different approaches in another institution with somewhat of a unique vision and mission should give fertile ground for researching into this implementation and testing the products.

A participant in the workshop indicated that, based on his judgment, 'They (staff) think there is some personal benefits attached to it or the name of the officer will rise high'. This statement suggests that those in the staff value contributions very much differently than others. In this case, benefits could mean so many things depending on the position of the staff member. For the purpose of this research and the workshop, we took it as intrinsic that benefits come with the promotion of an individual. Otherwise, the assertion could suggest an internal power struggle amongst staff to impress higher authorities. This kind of feeling is adequately addressed though a bottom-up approach where user participation is at the centre of the activities bringing about change from the start. Using methods like FW and codesign helps in allowing for some of those hidden voices to be heard. This institutional political feeling seems to be quite strong amongst staff, and this is one way that it is being expressed. There are, however, no documentations available or referred to as relating to such in the institution. What is known is that promotion is based on staff output in the form of either publications, community outreach based on innovative solutions or other scholarly work of academics. However, for administrative staff, the path is different.

6.2.3.7 Conclusion

Teachers significantly differ in the use of IT to enhance teaching and learning at Gulu University. Also, teachers have gaps in their pedagogical knowledge. The introduction of PBL and eLearning has resulted in redesign of the infrastructure for learning to afford for the new ways of learning in the resource constrained environment. ICT infrastructure at the time of this research was very poor, when compared with those in local internet cafes in the town. The staff therefore were taking on the use of dongles

to help access the internet services. The challenge with such was that it could not be supported by the IT staff nor the telecommunication companies that provide those data services.

ICT literacy and skills amongst staff were identified as the factors that could lead to slow adoption and change. This is a primary challenge to technology-enhanced learning, since the teachers will need much scaffolding to use IT services. The challenge escalates because the staffing level of the IT unit remains very thin in offering the much-needed support. The same will apply to continuous training of staff in PBL and how to implement it in the curriculum of their different disciplines. Thus, the PBL principles should be slowly and cautiously implemented across the university.

Looking at ICT infrastructure for learning, we can see that it requires institutional support in terms of strengthening ICT policy, and based on the proposed structures, increasing the ICT budget is a worthwhile goal. Network, server, bandwidth, other hardware and software issues are standard technological requirements that will remain important to harness the power of ICT in education. The other important issue is to strengthen the ICT support unit through additional staffing and to offer them specialised training to boost their expertise, user support and training built on PBL pedagogical knowledge. Thus, scaffolding of staff to blended learning at the university has to be taken seriously for the institution to reap the rewards from the current investment in infrastructure development.

CHAPTER 7. THEMATIC DISCUSSIONS

In this chapter, I will discuss my findings based on the analysis presented in Chapter 6. I have organised these discussions using the three major themes covering PBL, blended learning and LMS as infrastructure for learning, upon which this research on infrastructure for learning was based. In these sections, I explicate how to conceptualise sustainable infrastructures for learning in a resource limited setting. As I indicated in Chapter 1, the focus in this section will be on sociotechnical and sociocultural perspectives. I start by reaffirming that my empirical work was drawn from a selected workshop series conducted as a part of the larger BSU capacity building project and that the baseline study and workshops described in Chapters 5 and 6 are the ones upon which this research was positioned.

7.1. PROBLEM-BASED LEARNING

7.1.1. THE CONCEPT OF PBL

PBL is a general term which sometimes refers to the PBL and sometimes to problem and project based learning, depending on the university implementing it (Kolmos, 2009). The two models are used interchangeably with the PBL model that is preferred in health science-related studies while the problem and project based model is popular in engineering, humanities and other disciplines which is mentioned here as the Aalborg model (Dirckinck-Holmfeld, 2002; Kolmos, 2009). The different PBL models and the mix of them were explicitly discussed in our design workshops, offering both as equal choices for the participants, along with innovations/modifications to fit the learning activities of the university. In the workshops, case examples were drawn from Aalborg, McMaster and Maastricht universities' programme designs and implementation. These universities have been implementing PBL for over 40 years with it as a single model for university teaching and learning. The implementations in these cases have followed different strands as to how projects are initiated and implemented through the semesters, giving rise to the many other forms of PBL that are being practiced around the world. In Denmark, for example, Aalborg and Roskilde universities were specifically established with the PBL philosophy of problem and project based learning (Dirckinck-Holmfeld, 2002; Kolmos, 2009). PBL is built on constructivist learning, and more emphasis is put on students' collaborative project work, and it also draws on socio-constructivist learning principles (Dirckinck-Holmfeld, 2002). The choice of which model (or blend of models) is appropriate for use in Gulu University settings was left to the leaders and teachers to discuss, to execute and to organically grow in all programmes. PBL refers to many different models as seen from literature. However, in our case, it is the foundation organisation for planning and implementation of infrastructure for learning

because the infrastructure has to afford the pedagogy. This builds on the socio-constructivist learning philosophy exemplified through project work.

The workshops elaborated the PBL pedagogical principles with problems being the foundation for learning. In contrast to traditional curricula in medical education, the analysis shows that the teachers and managers focused on the process of learning rather than strictly on content. However, also within a process-oriented approach to learning, some of the teachers were agreeing on the need for explicating and detailing PBL as being critical, while others were supporting a more open flexible approach with more emphasis on the students as drivers and teachers and facilitators as supervisors. These differences in perceptions on PBL can also be found in the literature, such as Alkhasawneh et al. (2008) who documented in a study of PBL that, while assessing students' learning preferences, the process of preparing and explicating PBL is critical, and it is important to carefully address the skills, attitudes and knowledge gap through formulation and practice with real-world problems (see also Bell, 2010). In contrast, it seems as if the Aalborg model gives more responsibility and freedom to the students as the centre of learning activities, while the teachers take up the role of facilitators and supervisors in the PBL environment. The facilitator role is to essentially streamline and guide, but also to supervise the learning process, while learners work in small project groups (Kolmos, 2009). Through working in project groups, the claim in the Aalborg model is that the learners are afforded the chance to innovatively and collaboratively acquire new skills and construct knowledge around the learning object. The Aalborg model sees learning as a complex process that occurs in diverse ways that are difficult to control in a defined environment. Therefore, for Gulu University to achieve the goal of problem and project based learning, and to make learning and innovation happen in its setting, it is important to design learning environments that allow for what Dirckinck-Holmfeld (2002) referred to as proper learning' and to ensure that the students are not left alone, but supported by engaged academic facilitators and supervisors.

7.1.2. THE CONCEPT OF PBL AND IMPLEMENTATION STRATEGIES

According to the discussion in the baseline study, the concept of student-centred learning based on PBL is not new in Uganda or in East Africa. However, the conversation on PBL illustrates the different models as presented above.

In early 2000, Makerere University, through the Faculty of Medicine, developed a curriculum based on the principles of PBL (Kiguli-Malwadde et al., 2006). The curriculum was piloted with medical students but was soon dropped. Instead, competency-based education that is quite similar to PBL was later adopted. CBE has a detailed focus on carefully addressing the objectives, skills, attitudes and knowledge gap which teaching and learning should address.

The PBL strategy adopted at that time had a short life, despite its origin in the medial school. This was partly due to the uncertainty with the PBL model, and this can be somewhat be explained from an implementation point of view. As also described in the baseline study, the approach followed a mixture of expert-led approaches and management directives (top-down approach) in the design and implementation (Kiguli-Malwadde et al., 2006).

The mix of an expert-led approach and a participatory approach was conceived by the top management and directed to the staff. While that was the case for Makerere, the approach we used at Gulu University was more bottom-up starting with FWs and design workshops for teachers and administrators on PBL, forming a practical way to introduce it to the teachers who would be the active change agents based on successes of the implementation at micro-levels (in classrooms). Academics at Gulu University adopted the approach to suit competency-based and skills-based training required for progressive practice for health workers and in their training. One possible explanation for the failure of the programme would be based on the process of adoption and that Makerere possibly lacked the full participation and engagement of the teachers. Furthermore, it can be argued that the introduction of PBL in the medical school omitted exploring the analyses of processes and critical activities to establish connections linking historical dimensions with challenging possibilities of change.

7.1.3. INFRASTRUCTURE FOR LEARNING TO SUPPORT PBL

Investments in the most needed infrastructure for learning to support pedagogical alignment could help in settling some implementation issues at universities in developing countries in implementing PBL. In the case of Gulu University, we have explored the design of such an environment, resulting in many infrastructural issues within the university encompassing both technical and non-technical perspectives. In the workshops, the concept of infrastructure resulted in participants tending to focus their discussion around what is commonly known to be infrastructure, such as physical classroom space, furniture, teaching facilities (chalkboard, whiteboard, projectors and other consumables), with some also arguing for curriculum and teaching resources to be considered as infrastructure for learning. PBL speaks to these perspectives; thus, infrastructure has to afford these options.

As suggested by teachers, PBL pedagogy requires open spaces for students to work on campus, especially during their project periods. Physical space for learning was found to be a limiting factor in implementing PBL at Gulu University. The use of IT provides an alternative opportunity for students on weekend programmes (weekend programmes are a kind of distance education offered to professionals who can only come to campus on the weekends). Thus, participants (teachers and administrators) have to think of alternative uses of IT to create virtual learning spaces and to facilitate eLearning.

In the case of piloting the PBL principles with the Master of Education programme, this proved to be a good experiment for rethinking infrastructures for learning from a more holistic standpoint, than narrowing it to only traditional physical structures. The curriculum design workshop identified other structures, including IT and the curriculum, as the central elements upon which other infrastructure for learning are designed and built. This programme is not new. It had been run by the faculty of education and humanities for some time. Thus, redesigning it with the principles of PBL presented a good opportunity for learning and thinking about innovative ways of responding to societal needs.

7.1.4. HYBRID MODEL FOR PBL (BLENDED LEARNING)

The participants in the PBL workshop deliberated on the different modes of PBL, detailing the positive and the negative implications. The workshop then adopted a hybrid model that was based on the context of Gulu University resource availability. Integration of technology into the teaching and learning, capacity building and student assessment were notable key factors for teachers. This confirmed the findings from Costa Rica that teacher professional development programmes in these areas are central (Coto, 2010). The discussion then centred around the assessment criteria, questioning further to understand how it will be in the case of the Gulu University programmes. Assessment in a lecture-based delivery format is at the centre of promotion or completion of a study in the Ugandan education system (Deininger, 2003). Assessment periods follow the semester programme, and project work has to contribute to the coursework of students so that final examinations remain as the national guidelines. One participant described this format: 'Students' PBL projects will be assessed every semester. Students will be assessed based on a rubric that is agreed based on the curriculum. We have customised the Aalborg model to local Gulu University Context'. However, reporting the position of the department in its use of the Aalborg model of assessment is essentially contradictory because the curriculum follows the regular examinations where students have to sit three hours and continue with all forms of assessments.

The choice of the mode of PBL by the teachers will provide an environment for the proper learning to take place at the university so all basic requirements could be met in the near future. This programme, as I discussed in earlier chapters, was originally based on the teacher-centred approach and meant to train mostly administrators working in education related fields. The redesign activity that was done for the master's programme was partly a redesign of the work. In the same way, the design of the curriculum as a tool and integrating technology for teaching and learning fall between the micro- and macro-levels of material and intervention (Engeström, 2000). The dichotomy referred to as the meso-level befits the study of infrastructure for learning from a sociocultural viewpoint. Redesign of the curriculum with integration of ICT fits the meso-level where teachers suggest strategies for change that may not follow from what is already known from the literature (Nyvang & Bygholm, 2012).

The redesign process has encouraged decisions to revisit the pedagogy and integrate technology into the teaching and learning. Such a decision to integrate these innovative ways of learning in other programmes, even when the current curriculum was running, was not easily predictable. It is thus surprising that some teachers (such as those of psychology and history) have begun to use the approach in their teaching so that they engage the learners more effectively. Apart from knowing that teachers took PBL to their lectures, the details of how the teachers use the PBL principles in traditional settings could not be described as part of this study. The teachers maintain that they would want to integrate both PBL and eLearning in the curriculum and continue to teach to the current minimum of 75% in a semester. The interesting part of this is in the assessment where PBL is mentioned as contributing to the coursework part of assessment. Literally, at Gulu University, coursework is composed of series of tests, assignments (extended essays, short essays), and practical work. The practical work depends on the programme of study; otherwise, some of the humanities courses do not have a practical component. This practical part of the coursework is what was termed *short student projects* in the curriculum. The coursework score in the master's programme contributes 50% of the total semester score in a course unit. This means that the teacher (turned facilitator) has the flexibility to score based on the magnitude of the project that the student groups were engaged in through the semester.

To meet the requirements of the PBL as stated in the literature and to give learners enough exposure to the environment requires improvising their problem-solving skills, leadership skills and communication skills, so the teachers need to allocate more time to the students' projects. The present organisation of the curriculum falls short of the basics that can lead to the needed impact. Table 7.1 summarises how PBL should be organised to achieve the goal of improving the analytical skills and problem-solving skills of the graduates.

Table 7-1: Various ways of PBL organisation as presented at the workshop.

Organisation of contents	**Form of implementation**	**Analytical and methodological problem-solving**
Problem-based Contextualised Interdisciplinary Exemplary Action-oriented Theory and practice related	Team organised Participant directed Experience based Critically questioning Dialogue-based and democratic Directed by a facilitating tutor/teacher Often project organised or case-based	Project management Critical thinking Creativity, innovation, entrepreneurship Communication, negotiation, conflict resolution

This theoretical organisation of the PBL environment emphasises collaboration through project teams, democratic values and communication skills. The empirical study indicated that staff capacity to implement this pedagogy is lacking, despite their claim of already using it in their semester teaching. This is a contradiction because certainly teachers could be implementing something that is not clear to them, thus leading to the need for scaffolding. It is difficult to rule out the case of excitement for teachers to try out new approaches because the rules and division of labour amongst communities within the activity system have not been clearly determined. Even when this contradiction is true, it denotes that learning was taking place and that teachers are interested and exploring new ways of teaching and learning, even with the limited resources available. There are all indications of the need for scaffolding academic staff training in all areas of curriculum implementation to effectively realise the planned outcomes. One participant commented that 'implementation has had some challenges because not all the teachers attended the orientation and redesign of the curriculum. The department agreed that the teachers need refresher training in PBL based on the approved curriculum'.

Other participant discussion concentrated on the development of the learners at the university, focusing on the practical part of the learning, books and student projects, with less emphasis on the infrastructure to achieve such goals which was assumed to be implied. The supposed infrastructure is technical, and thus, only technical staff in their respective disciplines can design and create. Such division of labour along the lines of professional training contravenes the notion of interdisciplinarity on the design of learning environments. Student projects integrate knowledge from all relevant disciplines, so designing the learning environment while focusing on the leaners constitutes a dialectic process.

The programme for the Master of Education, for instance, is an attempt to organise the semester courses around various themes so that student projects can be easily integrated and jointly supervised by lecturers who share the resources in a specific semester. The organisation of the curriculum followed the Aalborg model (Dirckinck-Holmfeld, 2002), but deviated somewhat in the implementation. This is because the implementation maintained all aspects of the traditional curriculum, such as how assessment is organised and scored (examinations and coursework), with little contribution attributed to student group projects. These projects only account for about 25% of the coursework assessment, which is shared with regular tests and other forms of assessment based on traditional approaches. One argument advanced for progressive integration of PBL was that lecturers are not yet competent enough to handle the programme based on the PBL model and that institutional infrastructure is not able to afford the pedagogical requirements. The ICT infrastructure capability to handle all aspects of collaborative learning described in the PBL and resources for ICT services such as bandwidth and access are still lacking. For example, the

participants maintained that a functioning library with enough resources both physical and electronic (eBooks, journals and a collection of research publications) from within Uganda is a part of the infrastructure for learning that they recommend the university focus its attention on. This dialectic nature of infrastructure presents issues of managerial decision-making in how to achieve institutional objectives for development.

It is notable that the process of institutional change is naturally initiated through micro-level connected activities, designed to achieve goals, such as in this case, the introduction of PBL and eLearning into the master's programme curriculum to improve graduate employability through student-centred learning. However, the development of such programmes is a positive sign that the necessary change is coming into being because staff have demonstrated their willingness to revisit curriculum and make modifications. The strength is that, while other faculties in the university have been testing their programmes on other pedagogies, like the CBE in medicine, synergies are being built toward student-centred and technology-enhanced learning. The practice of students doing projects is slowly spreading to other science disciplines with only humanities and social sciences presenting few of these semester-based student group projects. In humanities and social sciences, the challenge is mostly based on the large number of students they have to handle vis-à-vis the few academics handling such workloads with the final year students who are subject to final research projects. In applied sciences, such as medicine and agriculture, their programmes are designed to expose students to work environments from their second year of study. In these programmes, the final years are based on practice integrated with community-based education, thus taking group projects seriously in the assessment. For students studying to become teachers, professional practice (school practice) is mandatory for the second and third years; however, assessments are based on individual performance during the time of placement. There is an indication that these practices would be set as part of the semester problems for student groups to help them build confidence in presentation and contextualisation of the lessons required of them in their respective specialisation teaching subjects. These approaches are not directly aligned with the problem and project-based learning, but this presents a fair point of departure to an innovative, interactive and student-centred learning format.

7.1.5. CHALLENGES WITH PBL INTEGRATION

The challenges faced in integrating PBL at Gulu University are similar to those which were also reported in other studies, such as the one done by the Faculty of Medicine at Makerere University. The fear is that the changes proposed in adopting integrating PBL need more personnel and resources than the traditional teacher-centred approaches in practice today and will change the lecturer role to a facilitator role (Kiguli-Malwadde et al., 2006). These changes are seen to reduce their level of expertise in the subject area, thus reducing their control of the learning environment.

Also, there is a need for scaffolding members through the curriculum to help them appreciate what can be achieved (Kiguli-Malwadde et al., 2006; Oliver, 2011). Staff motivation was another issue that presented challenges to get staff to appreciate the new developments of their ideas. However, in the analysis, I did not consider this in this study in detail, but it presents some contradictions to management about how to determine the nature of motivation (intrinsic or extrinsic), which was implied by the participants. The participants pointed out the increased workload on the staff as a result of the new approach. Similarly, in the case of Makerere University, the staff complained that 'tutoring is not as rewarding while it is time-consuming' (Kiguli-Malwadde et al., 2006). The staff also feared additional loads resulting from student project supervision based on high enrolment that is experienced even at postgraduate level because the university adds about 40 new students per academic year per graduate programme.

Some staff challenged the speed at which PBL is integrated against their preparedness to implement it effectively because a cross section of their colleagues have not fully participated in the PBL workshop series. Similar findings were reported in Makerere where staff found it difficult to implement the curriculum because it was introduced suddenly (Kiguli-Malwadde et al., 2006). The implementation was met with challenges because, although the staff wanted to engage students through short community-based projects during the semester, the accredited curriculum duration was short of what was needed as it had apportioned very little time for it (about 25% shared with other semester coursework), and the score for it was also rationed as part of the 50% contribution to semester score. More time was then allocated for teaching, just like in the traditional teacher-centred approach. The 75% teaching load is applicable as an indicator of syllabus coverage, and projects are not mandatory across semesters. Figure 7-1 is indicative of the design for Master of Education (MED) programme at Gulu University. This is a sign that staff need further scaffolding to enhance their capacity to design new programmes and manage change. This could otherwise be taken as a form staff resistance to change in the teaching and learning at the university. An extract of the approved programme indicated how the programme was neatly organised, but the allocation in the implementation hours remained as it had been for the teacher-centred approach.

4.12 PROGRAMME STRUCTURE

Details of the programme structure are specified below as; **Lecture Hours = LH, Tutorial Hours = TH, Practical Hours = PH, Contact Hours= CH respectively.**

YEAR ONE

SEMESTER ONE

COURSE CODE	COURSE TITLE	LH	TH	PH	CH	CU
MEM 7101	Research theory and Practice	30	20	10	45	03
MEM 7102	Qualitative Research Methods	30	15	15	45	03
MEM 7103	Introductory Applied Statistics	30	10	20	45	03
MEM 7104	Scholarly writings and Publication Skills	30	10	20	45	03
MEM 7105	Contemporary Organisation Theory	30	15	15	45	03
MEM 7106	Introduction to Information & Communication Technology	30	10	20	45	03
TOTAL		**210**	**100**	**110**	**315**	**18**

Figure 7-1: The course organisation for the MED programme.

This design is based on what was adopted with modification from alternatives presented through literature and from Aalborg University as in Figure 7-1. The adopted PBL model organises courses in thematic groups, and a project is formulated that integrates the concepts from all the courses taught that semester (Figure 7-2) with the assumption that all the facilitators for these courses automatically become project supervisors. They follow through to grade student projects where group and individual competencies are scored

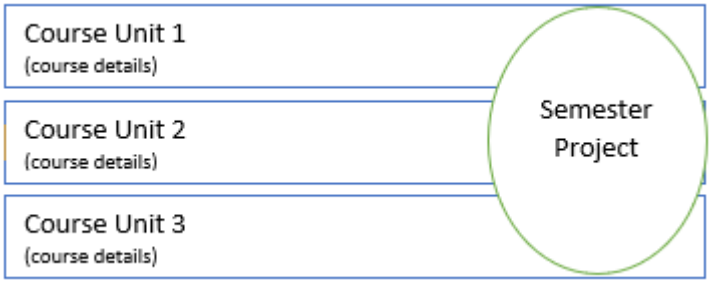

Figure 7-2: Logical PBL curriculum course design by semester.

This design covers the core course units 1, 2 and 3, thus forming the respective themes of the semester project, while electives would serve as alternative resources for the learners. The students formulate problems in relation to the semester themes and present these to the facilitators as the semester progresses.

7.1.6. RESOURCES AND INFRASTRUCTURE FOR PBL

Resources form the foundation for the success of PBL implementation at a university. The NCHE noted in their report that many higher education institutions are in dire need of space as infrastructure (NCHE, 2018). The report indicated that each student requires about 1.01 square meters of space. This confirmed staff recommendations for more physical space, compared with technology integration that is slowly receiving attention from the university.

The empirical work revealed that currently the student to computer ratio is above the recommended standards by the national council at 5:1. Access to computers as part of infrastructure for learning is important to both the learners and the teachers. The NCHE reported that the number of computers for learning improved by nearly 14% in the years 2014–2015 (NCHE, 2018). However, the number of laptops is also on the rise as technology was has become more affordable, which was noted in the report. The recommendation is for the university to adopt the BYOD format as it may reduce the workload of IT support and the cost of maintaining computer laboratories.

This study found that there are no readily available electronic resources in the university library, especially for library users from the humanities and social sciences. The staff in these disciplines indicated that they occasionally use the library for lack of other resources. Of course, there are physical books in the library, although many of these books are relatively old publications that do not address new innovative pedagogies. Developing an eLibrary and expanding the reading and discussion space are additionally fundamental to the success of achieving the goals of introducing PBL pedagogy. The NCHE reported that, on average, students currently have access to 1:40 hard copy books which is far below their recommendation of 1:11 (NCHE, 2018) necessitating a move to eLibrary to resolve this gap. This is the same case for Gulu University where students are reportedly using lecture notes as their resource. However, the study concerning student experiences is not handled in this dissertation.

7.2. BLENDED LEARNING

The term *blended learning* encompasses many modalities of leaning, making it a broad concept. In this study of technology integration and PBL in resource constrained settings, we consider blended learning to be composed of a mix of traditional teacher pedagogy, PBL and eLearning. This is because the three are implemented concurrently, and the same infrastructure for learning is leveraged for all pedagogies. The use of IT with lecture-based teaching in the traditional classroom environment

constitutes a part of the blended learning, just like PBL and eLearning. The study of infrastructure for learning has to be in relation to practice, meaning that empirical work is done both in the practice and in the different technologies (Guribye, 2005). Start and Ruhleder (1996) asserted that infrastructure cannot be studied as a thing. What can be studied is always a relationship or infinite regression of relationships (Star & Ruhleder, 1996). The unifying technology implemented as the first prototype at the moment is the LMS based on Moodle. I will now discuss the perspectives of the PBL, technology-enhanced learning, lecture-based teaching, the use of IT and the ICT infrastructure for learning based on Moodle.

Universities in developing countries are very important in the creation and consumption of knowledge and information (Teferra & Altbachl, 2004). Institutions such as Gulu University struggle with poor infrastructure that is not only poor but also inadequate based on the circumstances it is in. The use of IT and ITC in enhancing teaching and learning is taking root in Ugandan universities. In the baseline study, we found that universities are developing tools and acquiring information technologies and building their infrastructures for learning. The current settings are very limiting for the institutions in their efforts to provide adequate services on the ICT platforms. The results showed that these institutions will help them achieve institutional sociocultural objectives by shaping activities in the learning environment when cognitive activities of ICT are integrated in planning, enactment and assessment of learning activities (Lim, 2002). This would also require a change in the pedagogy where the delivery medium is mixed. Learners will also have to adjust so as to effectively use ICT to shape university activities (Lim, 2002). Also, as the staff claimed in the workshops, the use of ICT is widespread amongst them in the university, but the power of ICTs in organising educational activities is often not documented. Lim (2002) noted that there is a belief that such tools are a result of necessary factors, rather than the more concrete sociocultural factors, showing that cognitive activities are not directly consumed in the learning environment. Citing an example of the use of a Microsoft Office application, it was noted that only a small portion of such tools are often used by experienced users (Lim, 2002). These situations often occur as a result of the fact that ICT application is relatively new in higher education in such settings, so this makes training a strong part of infrastructure for learning development. Over the years the use of ICTs in the education domain has developed from individual interested teachers to the level of institutional commitment (Nyvang & Bygholm, 2012). This increase in the use of ICT at the university has however led to a mixed application in university programmes. It must be remembered that the institutions that participated had their programmes based on the traditional teacher-centred approach.

To understand the role of ICT in teaching and learning in higher institutions in Uganda, factors such as technological attributes, user, and content characteristics, technological consideration and organisational capacity must be considered (Guma, Faruque, & Khushi, 2013). These characteristics have played a part in the way ICT

has been adopted in the institutions that we studied. Makerere, Muni, UCU and Kyambogo were found to be ahead in infrastructural development compared with Busitema and Gulu. This must have been because of the integration being influenced by organisational and/or institutional factors as reported in Guma et al. (2013). It should be noted that the all these institutions use the same LMS. As much as this is true, Makerere has tried three LMS-supported eLearning initiatives in about 10 years (Ssekakubo et al., 2011). The decision on which technology to adopt when it comes to technology-enhanced learning (or blended learning as referred to here) requires careful contextualisation. An interviewee from Busitema suggested that experiences from and collaboration with Makerere University played a decisive role in adopting Moodle as their core infrastructure for learning. Through inter-university collaboration, Gulu University also received technical guidance from Maseno University eCampus through the BSU project. However, Moodle developers are known to sometimes offer free technical and user support for all categories of users. Moodle as a core infrastructure is regularly a compromise amongst in-house development, open source and proprietary solutions because of resource constraints (see Jones, 2008; Kumar & Gankotiya, 2011). The infrastructure design also factored in interoperability (Jones, 2008) and being modular, and scalability functions are embedded in the system in response to new institutional infrastructure for learning user requirements. Using some of the cultural and historical information in these activities, these institutions have therefore gone through stages of expansive learning (Engeström, 2001).

The IT infrastructure presents itself as the mediation tool amongst the actors in the learning environment. Technology as the mediator builds the sociotechnical practice between and with the community of teachers and learners and administrators of the higher institution of learning.

According to Guribye (2005 p.43), 'the mastery of such technology tools is important in understanding the relationship between learning and ICT'. This definite consideration could lead to designing and building sustainable infrastructures that are user-friendly and effective in enhancing the use functions of the technology. Infrastructure for learning is a collection of tools (Guribye, 2005) designed and manufactured or implemented by many actors. These tools extend the space for technology artefacts, specialised software such as LMSs, policies and the central documents based on preferred pedagogy. Some of these technologies are designed to support, manage, organise and deliver learning activities (Guribye, 2005). In our case, the infrastructure has been designed with the student-centred perspective based on the principles of PBL to encourage learners collaborate, discuss and participate in tutorials through the use of an IT infrastructure.

In relation to mediation, the sociocultural perspective assumes a symmetry in relation to humans and artefacts (Guribye, 2005). This relationship is based on conceptually layered arrangements that present theories from the top layer with experiences in the

middle and technologies in the bottom layers. The researcher's position is that this should be a dialectic arrangement that sees user experiences, in this case, taken to the top so that theories and technologies are in support of the learners' needs. Teacher (user) experiences should shape the relationship between the theories and technologies that support teaching and learning. The content and pedagogical design of learning modules is the professional responsibility of the teachers, so their perspectives on teaching in the future should be respected, and the way to respect that view is to collaborate with them as researchers.

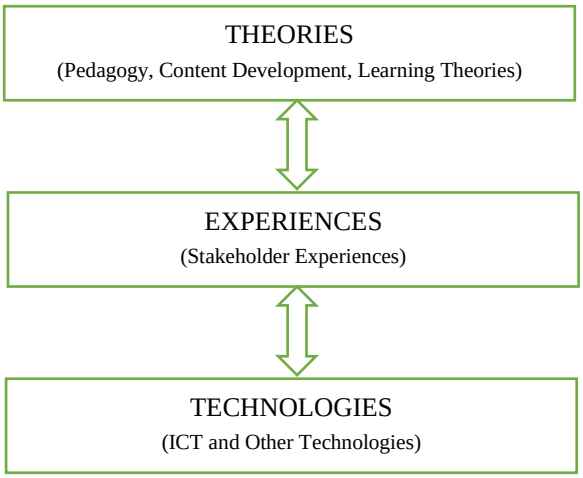

Figure 7-3: Theories, experiences and technologies.

The technologies decided upon therefore should afford the practices of teaching and learning in conformity with the theories. User experiences in a blended learning environment differ from place to place because of different factors, such as the competence, skills, accessibility and availability of technologies adopted that are adopted.

7.2.1. PBL AND TECHNOLOGY-ENHANCED LEARNING

The PBL principles are based on and form the core of the learner-centred perspective (Dirckinck-Holmfeld, 2002). The design of the infrastructure would then take a point of departure from there to allow for practices that relate to the acquisition of tools and artefacts to deliver collaborative learning. These tools are linked and are integrated on an installed base consisting of technological and non-technological arrangements that then become infrastructures in relation to practice (Guribye, 2005). The lack of an implementation framework of the adopted PBL and blended learning was noted because the resource allocation was more aligned to the traditional teacher-centred approach. The need for more physical space, such as classrooms with chalkboards, whiteboards, and teacher presence in the class, are measures of teaching and learning

infrastructure. The new PBL approach of facilitating teaching and learning has not been firmly rooted with the teachers at the moment, so teachers tend to rely on their cultural and historical teacher-centred approach. This is most probably a mindset issue of the teachers imagining the complexity that this change might bring to their already established system of work.

The sociocultural perspective of IT remains underexplored in this setting. This is especially so in researching infrastructures for learning with ICT as the central infrastructure. ICT at the university should be viewed as a mediating artefact in understanding its use in human professional activity (Guribye, 2015). The use of FWs was new in the research settings that proved to be effective in getting insights into the participants' use of ICT. To attest to this, in the last workshop, a participant submitted that ICT from a sociotechnical perspective was being viewed by users at the university as a symbol rather than as a tool for learning. The actual use of the artefacts that are in modern offices and what they provide can be debatable based on the potential these technologies offer to the user compared with user skills and actual use.

Some of the services that technology would provide were realised during the CoED workshop where users of these technologies became further aware of the potentials of those tools for teaching and learning. They were also able to theoretically relate to the available technologies as resources to address pedagogical concerns about the new ways of teaching and learning. The opportunities that can come with technology of various types in teaching and learning were highlighted. This was coupled with the PBL approach to appreciate the need to work with students and seek answers to some of the real-world problems that affect the community (James, 2006). In fact, participants noted also that ICT is very subjective, and it affects ways teachers do their work. One participant acknowledged that 'when people look at computers, they see different things depending on the sociocultural orientation'.

Thus, the interaction between users and computer artefacts creates a social phenomenon. However, depending on the cultural preference of the user, the interaction presents the whole process that makes ICT very much subjective to the ways of work. In order to understand ICT, one needs to look beyond the artefacts and tools. It is important to understand the interaction with such artefacts and tools to define the kind of ICT that is needed in the workplace. Teachers need to define their work environment based on the fact that ICT tools or artefacts are subjective and affect the way we organise and deliver their outputs. For example, the way teachers organise their materials for teaching is based on the infrastructure provided for learning and generally on the tools that are familiar to them. Also, ICT requirements vary with user competency and the nature of the work in which an individual is involved (i.e. technical, support, application). Teaching online is very different from lecturing because the high level of preparation and support required by the learners. Moodle has many tools for collaboration, but the way a user navigates around the infrastructure requires some level of skill to master this. We note here that IT infrastructure is simply

playing a mediation role to facilitate learning. This is also about teaching and learning resources that a teacher requires to prepare learning materials for Moodle. Availability of resources in the library in the form of eBooks and subscribed online journals form the eLibrary reference materials that substantially support the IT infrastructure.

To afford pedagogical principles, the infrastructure for learning has to be understood in a holistic manner, other than in the narrow perception of managers on infrastructure for learning, based solely on physical resources and spaces. These kinds of managerial viewpoints underscore the classification of infrastructures as open, shared, evolving, heterogeneous and existing on an installed base as summarised in Guribye (2005).

Generally, academic staff noted that every one of them uses ICT at least for information searching and preparation of lecture materials. But, some teachers stated that they are not ready for the use ICT in teaching because they are not sure of their data that is uploaded onto computer systems. The issue of another staff member using the same material, in case they are allocated another course unit, combined with the security of the information and data they make available online, was the problem. ICT provides a very open system that allows the teachers less control of their materials as soon as they make them accessible for learners. However, with the use of Moodle as infrastructure, all teachers have control over their resources. The IT unit's staff are ethically mandated to keep the system running above all else. A member of the IT unit explained to the participants that this works like institutional email and that teachers need not worry about their integrity and can trust that they will professionally work to help them through the process.

7.3. MOODLE AS INFRASTRUCTURE FOR LEARNING

Moodle is a computer software program designed to facilitate learning over the internet (Sclater, 2008). The application runs on a web server of the institution or on a contracted company web server on behalf of the institution. Its development is based on a firm pedagogical principle. Moodle is designed to integrate a number of tools and technologies used in e-Learning and blended learning. Such tools include discussion board, wikis and real-time chats (Riznar, 2009) to support learner collaboration and interaction, just as they would do in a PBL learning situation. However, an LMS also has good administration capabilities, integrated monitoring tools, support design templates and publication of reusable learning materials (Ssekakubo et al., 2011). These attributes of Moodle as IT infrastructure for learning are robust and offer teachers the opportunity for adopt new ways to creatively use the technology at work. But, again, the investment in virtual learning platforms in support of heterogenous learning processes requires a strong IT infrastructure (Despotović-Zrakić et al., 2012).

The IT infrastructure for learning, in this case, consists of a scaleup on a system with an installed base (Guribye, 2005; Star & Ruhleder, 1996). The installation of Moodle depended on existing systems that support learning at the institution, such as the

network infrastructure, and the human and institutional structure. The LMS is therefore an embedded system that operates within the established technical and social structures that have been identified (Star & Ruhleder, 1996). The LMS offers another service in addition to other services, such as email, human resource databases, computerised accounting and eGovernment, that were already running. It has an additional system that is adds to its scope (Guribye, 2015; Star & Ruhleder, 1996) to give alternatives to making education services accessible to a wider community, while maintaining the same for on campus learners. The social practices defined by the organisation shape institutional systems with which infrastructure is intertwined (Star & Ruhleder, 1996). Teaching and learning could be taken as a social practice that higher education sector is engaged in as mandated by law. This core practice shapes infrastructural design and implementation at universities and other tertiary institutions. Some examples can be drawn for the findings from the baseline study where institutions were found to be working to introduce eLearning despite resource limitation.

LMSs are integrated systems to support activities of the teachers and students in an eLearning process (Despotović-Zrakić et al., 2012). The design of such a system should therefore conform to its use. In the case of Gulu University, the LMS, Moodle, was collaboratively designed with the university/users' vision to embrace eLearning. The teachers emphasised the need for the system to afford pedagogical principles and, specifically, the learning outcomes stipulated in the curriculum. The teachers were very keen about their activities and delivering results to meet the expectations of the learners. As such, the design was made simple, based on user needs, with the option to scaleup easily as users' experiences grew over time to a higher demand for advanced services. Notably, eLearning has become a widely accepted mode of learning leading to unavoidable massive usage of global networks in the education process (Despotović-Zrakić et al., 2012). This move is healthy and challenging for institutions with limited resources, especially those in Africa. Thus, a humble beginning based on resource availability and other hindering factors is key to national and international collaboration and standards to deliver the learning outcomes.

The CHAT (Engeström 1987, 2000) provided the theoretical lens for understanding how such a design could be achieved. Although the design was a subject of the study here, it was also an activity from which a tangible product of the workshop was presented. As an activity system, the subject of the activity is the design with the object being the LMS with the outcome that the learning objectives have been achieved.

The design phase resulted in less complicated designs by the participants in order to reduce any negative effects of Moodle and user confusion in navigating their way through the LMS. The final design has given participants inspiration to use the system features with basic functions. The primary aim of the system is scalability over time as other modules will be added based on demand and because the capacity of the university is limited to sustain the system even in its basic form.

The design team and IT personnel made some demos based on simple and clean templates for further discussion and recommendation. These demos concentrated on blocks, themes, display and colour schemes based on recommendations by the participants to institutionalise the system, even though it is in its initial stage of development. Alternative design options are exemplified in the screen shots in Figure 7-4.

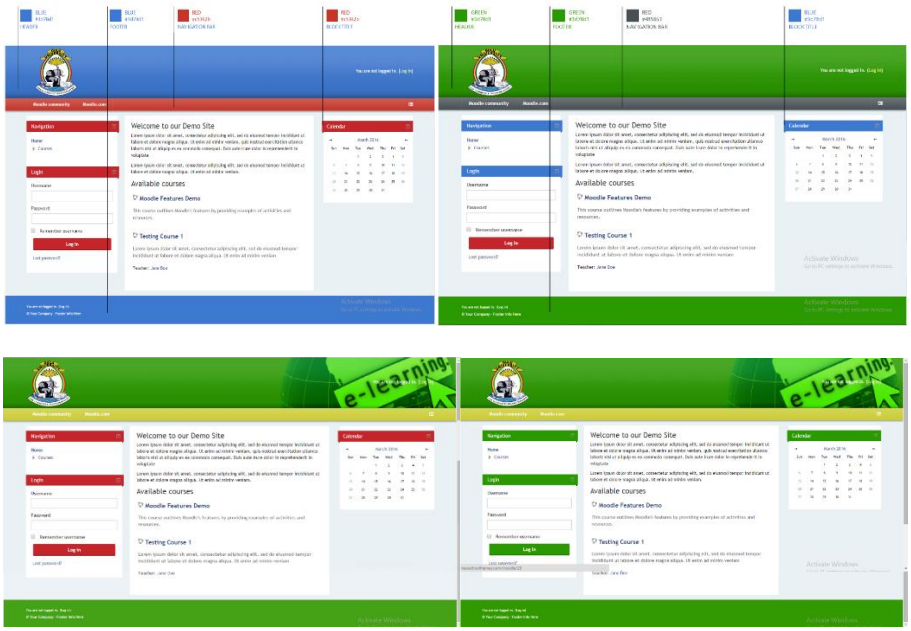

Figure 7-4: Interface design options.

An acceptable design was further developed into a working prototype that is undergoing further development as it is being used for projects and other activities relating to staff training and capacity development. The teachers have been very specific about the design in terms of the need for scaffolding to address basic navigation issues fast. They were also cautious about students' skills to get through the system with ease. The emphasis has been on content design to be in line with the pedagogical principles and how to effectively deliver content to the learners even when they are new to the system.

The simplicity of the design indicates that the teachers are aware of the challenges of the system being rejected by their colleagues once it is rolled out. Competency and skills of the teachers to use ICTs were seen to be a factor in resistance. This contradicts the position that teachers are already using ICTs for teaching. Also, various questions have been raised: What ICTs are being used by the teachers? Is Moodle the only system that requires teacher training? Which alternative LMSs are teachers familiar

with? These interrogations presented ICT as a sociocultural style of work, but the actual use of the artefact is not for teaching and learning. A teacher claimed that they use laptops and projectors to help them teach and use the internet to search for information, but do not upload learning materials online and teach online. Thus, having simple templates with clean and simple navigation interfaces is important at the beginning. With more teacher training and professional development using ICTs, more functions can be added to the system. The interface of the working prototype of the LMS has very simple modules and functions as was described by the teachers. The rooms are easy to find, and services are readily available. All these are shown in Figures 7-5, 7-6 and 7-7.

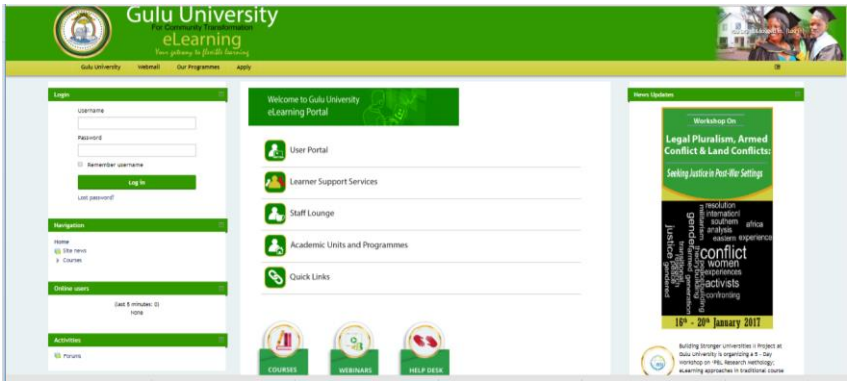

Figure 7-5: Interface design of the LMS prototype.

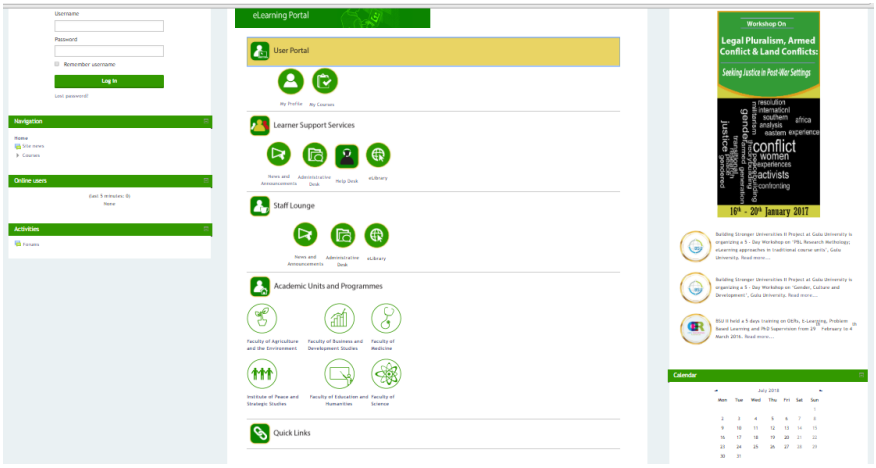

Figure 7-6: A display of the user portal with simple identifiable objects and actions.

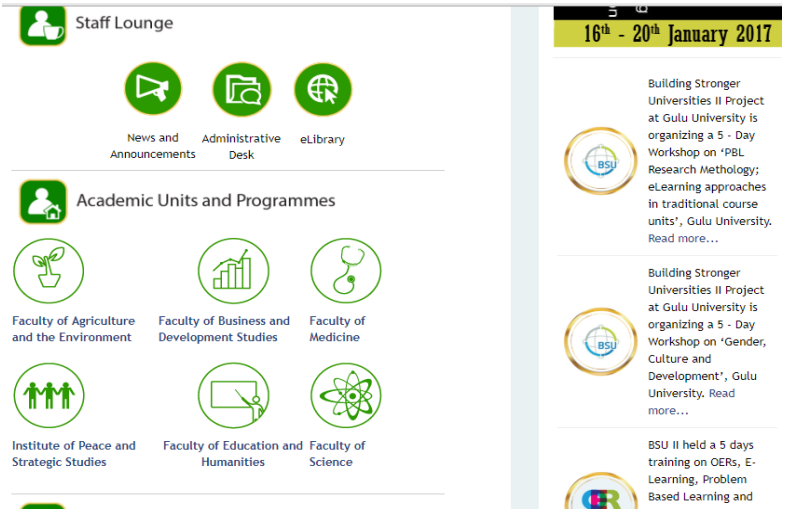

Figure 7-7: A closer look at the staff lounge and academic units.

The interface design ideas were captured based on the design proposed by the teachers who are the immediate users of the system. Keen interest was on the activities of the users and how these simplified processes can be integrated in the technology. A plus here is that the user spectrum on Moodle is very diverse with unique characteristics and needs (Despotović-Zrakić et al., 2012)

The LMS infrastructure is built and customised to apply some of the principles of the PBL learning approach. The tools integrated in the infrastructure are meant for the infrastructure to afford these principles. The chat and wiki functions in Moodle are meant to facilitate real-time discussions and meetings online. These functions require that users have some basic skills such as typing that are also noted to be a challenge. Such skill is built through continuous use of computers and sometimes using training applications that are readily available online. This represents some of the basic individual challenges in using ICT, let alone for teaching. The complete LMS has some core elements for learners to follow and socially construct meaning based on their interaction with the system. These are meant to present a constructivist perspective to learning on which project and problem-based learning is grounded.

Using the functions in the Moodle, the general technological environment presents opportunities for learners and teachers to engage in collaborative learning activities.

The teachers have their designated role with space to work, follow and moderate learner interactions through the chat and wiki with interactive feedback options.

This research being an intervention-based project looked at the pedagogy as central to the design of IT infrastructure for learning. The infrastructure which then has to afford the pedagogy by providing the much needed tools and solutions required by the curriculum(s). Gulu University runs two pedagogical approaches with the third being PBL that is yet to obtain accreditation. However, the most known approach in the country is the lecture-based method, which is then followed by the CBE in the medical school. So, while this study emphasised on the PBL, other participants have variant views about how the IT infrastructure can afford existing approaches, too. These diversities cannot be discussed further here since the focus of the study was shaped by PBL. But, this confirms the diversity of users of infrastructure for learning (Despotović-Zrakić et al., 2012), making design research an activity very vital for the success of desired outcomes.

There are differences in the teaching approaches with and without technology. The integration of ICT bridges the gap between traditional teaching and PBL. This was initially the case in respect to the present curriculum that took a full cycle of three years during which the redesign was made. Techers have had opportunity to practice and address some of the sociocultural aspects of ICT integration through their actual practice. It is also clear that PBL principles have not been fully captured by the staff. At the time, Moodle functionality remains low as staff learning still needs to be scaffolded. Thus, user experiences presuppose the macro- and micro-levels of knowledge, as show in Figure 7-8.

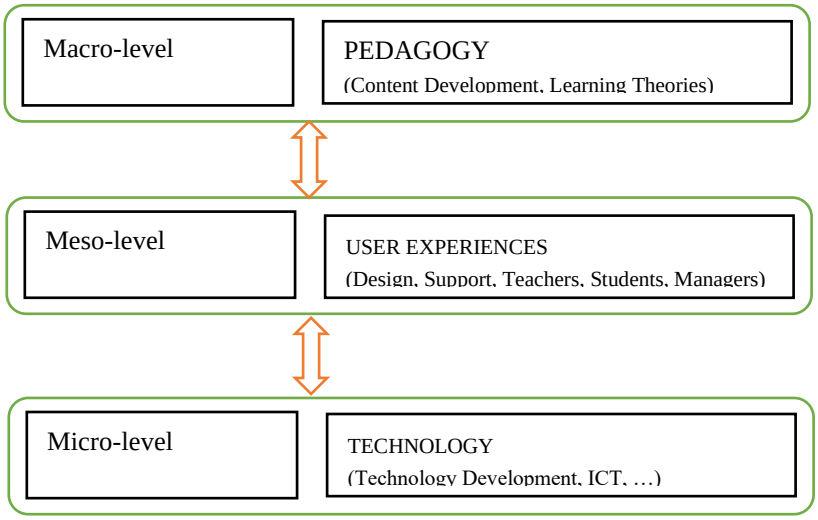

Figure 7-8: Positioning ICT, user experiences and pedagogy within a system.

7.3.1. AFFORDANCES WITH MOODLE

The learning environment where ICT is integrated should be studied in context so as to understand how ICT affords learning in the situation. Research has shown that ICT has often triggered changes in activities, curriculum and social relationships in the learning environment and is mutually affected by the same changes it causes (Lim, 2002). The design of IT infrastructure should afford the curriculum and other work environment activities within the institution. It is important, therefore, to consider the social processes that ICT supports during its use and how it is integrated in the learning to develop higher-order thinking skills (Lim, 2002). These are sociocultural perspectives that are addressed through ICT integration in the education domain. The AT framework (Engeström, 2000) was adopted here to provide the theoretical lens for understanding the affordances of ICT to the practice of teaching and learning in higher institution of learning.

The IT infrastructure based on the implemented LMS was used extensively for running the workshops. These workshops having part of their participation on the LMS served dual functions. Lecturers attending the workshop had to be registered on the system so that workshop materials would be accessible to them. This allowed for the system to receive some checks by users intermittently during its design and implementation. Complaints about the functionality, usability, availability and reliability could be answered through improving its design and reworking the needed modules as demanded by users. Self-orientation and walk-throughs by these lecturers were deemed to be ongoing through the workshops.

It was impossible to measure the affordances of the infrastructure because the pilot course was not ready at the time of the study. The process of accreditation was based on external organisation for which there was no control by the implementing university, thus making it difficult to test the implementation on a course that had not passed the criteria of accreditation. One recommendation is for another study that would look at the infrastructure from the micro-level to examine the affordances in relation to the pedagogical principles described in the new curriculum. This could be in the Master of Education Planning, Management and Administration or another accredited programme. The choices here are to study the affordance to the blended learning or to the programmes designed based on PBL and to explain how the ICT tools have been used and how useful they have been in relation to achieving pedagogical requirements (Guribye, 2005).

7.4. POLICIES AND STANDARDS IN INFRASTRUCTURE FOR LEARNING

The sociotechnical perspective on infrastructure for learning is concerned with linking IT with social organisation settings and characteristics to which the technology would be afforded. It is also the promotion of mutuality of designs to inform technology innovation and social organisational characteristics that define the work environment. The mutuality is geared at achieving a desired humane fit aligned with the sociocultural and sociotechnical perspectives of the stakeholders.

It is important to understand the knowledge gap for the administrative and academic staff in the use of the current technologies available at the university. The identified challenges will feed into the redesign of the infrastructure and serve as requirements for new interventions. Another dilemma that needs resolving is in the kind of professional learning that administrators and academic staff would require to effectively use information technologies. What is known is that the different levels of expertise of the staff affect the use of IT to support teaching and learning. Answers to these questions would provide micro-level understanding of how-to better design ITC for learning.

7.4.1. IT POLICY

The institutional IT is governed through a central policy. This policy provides the needed structures for all other relevant ICT policies that support the accomplishment of the institution's vision by broadly stating the issues related to best practice, roles and responsibilities of user groups, general guidance to implementation and usage of ICTs (Makerere, 2016). Such a policy is therefore a governance structure that provides a favourable environment to align all ICT investments geared toward achieving organisational goals. It helps organisations effectively plan, organise and streamline the management and effective utilisation of ICTs (Makerere, 2016).

One of the challenges with the design and implementation of the new blended learning is based on the fact that the institution does not have a functional ICT policy to guide the use and management of these technologies. This policy that, according to one of the participants, was drafted over a decade ago in collaboration with the Faculty of Computing and IT at Makerere University through a project but was never approved by the university council. Copies of such a public document are not readily available, even to the technical and support staff at the ICT unit. However, during the workshop, members of administration argued that it was approved, but they did not have the approved copy of it. With these contradictions, the most obvious conclusion that was drawn from the workshop was that the document was actually not approved as claimed by some section of the administration. Further to this, the setting in which this was approved was not made known to the IT unit. The deep-seated issue here is the legality of this document that governs all otherwise related ICT matters of the institution

(Kyambogo University Council, 2015; Makerere, 2016). The technical team at the university could not then proceed to make proposals on acquisition, installation and management without consulting such a policy document, meaning that a crucial element of the infrastructure for learning was lacking and would have to be developed. In this case, we see that policies are the lubricating factors that keep the human and technology infrastructures intact because if the latter cannot be procured and installed then neither will the human infrastructure be able to control users of such a system. As I discussed earlier, human infrastructure essentially defines the technical user groups of the IT systems in the institution.

The draft policy then, according to a participant from the ICT unit, focused on development of ICT at the university but was silent on ICT as a resource and its usage amongst the university community. As infrastructure for learning, the policy has to address both future development and use cases within the user groups meant to enhance work within an organisational environment. The user input to the policy at this time then would have to follow a sociotechnical perspective because these users are involved and/or participating in the infrastructure design through consultations. The technical team would then work with design groups at different levels within the institution in an attempt to include all affected groups in decision-making (Mumford, 1983). The assumption here is that users' skills and knowledge (Mumford, 1983) need to contribute to the design of this policy. The team therefore tries to adopt a holistic approach to policy development so that some of the omissions highlighted in the previous policy will not be repeated.

This would not only lead to the development of a management tool but would also lead to a change in the perceptions of the staff (Mumford, 2006). The participation of the all stakeholders in the development of the policy brings forth the idea of sustainability and ownership of such a policy. The use of PD (Mumford, 1983; Spinuzzi, 2005) in this study therefore revealed new ways of developing systems together in an institution presenting an opportunity to hear voices from all its stakeholders. The direct involvement of people in the codesign of tools and products ensures that the products are correctly aligned to human needs (Robertson & Simonsen, 2012).

In the development of an ICT policy for the institution, the team should then address alongside the technical development, the use policy, security policy, password and communication (email) policies. In addition, the policy should also produce a standard operating policy for proper accountability purposes. Technical guidelines for the implementation of blended learning or eLearning at Gulu University would be developed through an expert-led or sociotechnical approach (Baxter & Sommerville, 2011). Such policies and an ICT master plan should be available to the users for ease of reference and adherence.

The need for a formal ICT management structure was another identified weak point for the unit and the implementation of the infrastructure. A participant noted that these structural establishments are needed to support service delivery, on the one hand, and ensure accountability of management of these IT infrastructure investments on the other. The lack of some of these management tools could have led to the further problems within the already resource limited setting at the university because there is no clear roadmap of how IT infrastructures were acquired and how they are being used and there are no plans for what needs to be procured. Within the resource constrained settings, it would be beneficial to develop systems that are acceptable and available for sharing resources. The use of the sociotechnical approach would lead to developing such a system (Baxter & Sommerville, 2011); however, with integration of the sociocultural perspective (Lim, 2002), this would also strengthen ownership and sustainability.

Allocation of financial resources toward achieving the goal of creating functional structures for the ICT unit will result in strengthening that aspect of the IT infrastructure. To address the need for twenty-first century skills, higher education has to deal with financing resources for the staff and infrastructure; otherwise, staff turnover will increase because of better working conditions and competitive salaries and emoluments being offered elsewhere (Teferra & Altbachl, 2004). So, the policy should help address some of these disparities in infrastructure development at higher education institutions.

7.4.2. PROPOSAL FOR SOME DESIGN PRINCIPLES

As noted in the presentation in Chapter 5, PD and user-centred design have notably been broadly applied in pedagogical, philosophical (Spinuzzi, 2005) and technical (Bannon & Ehn, 2012) disciplines. While PD methodology is known to spur understanding of knowledge by engaging with the process (Spinuzzi, 2005), it also offers a wide range of design methods that are intertwined. These methods provide alternative pathways to designing for change that is central to infrastructure for learning. In this research, three of these methods were used. Based on the literature and participant feedback and my own reflections on the research process, I want to propose some design principles related to the research process and results herein. This summary could be beneficial to researchers as a reference in doing research that follows these methods. However, design principles are a reflection of the condition in which they operate (Anderson & Shattuck, 2012). This is not purely design-based research, but as I indicated, the proposals could help to evaluate the process that brought about conclusions that relate to a similar study. I cannot however claim that these proposals are exhaustive enough as research environments differ spatially and temporally, and they vary as to the choice of participants and the duration of the empirical work. Designing is an evolving process that starts from and leads to developments of practical design principles (Anderson & Shattuck, 2012).

In Table 7-2, I present the summarised design principles in relation to the methods adopted for this study.

Table 7-2: Proposed design principles.

Design principle	Specifications	Method
Organise workshop that grounds participants knowledge and allows active participation	Historical issues Current situation Desired future	FW
The design environment	Mix participants from all sectors in the design environment	
Description of facilitator profile	Develop contents collaboratively with a local facilitator, thus reducing unreasonable expectations; consider professional and cultural differences in the case of the facilitator's profile; two or three facilitators complement each other well; alternative views are presented	Meetings (virtual and physical)
Reflection on critical issues to energise discussions	Short presentation in any form (electronic, verbal or otherwise in groups or plenary sessions) for 3–5 minutes; identification of bottlenecks and proposing solutions collectively (what works and what does not)	Short presentations or FW phases
Encourage individual participation and support them through collaborative learning	Provide online activities to the participants early on; encourage peer-to-peer interaction and critical positive feedback on any submission; rotational roles in groups should be encouraged	Groupwork and plenary discussions.

	to allow all-round participation and inclusion	
Use of local materials to capture the context is important	Allow the participants to use local materials for design; critical thinking with card sorting and matching; frequent interaction with design prototypes; reflection exercises to relate to the context and design environment	CoED
Reflection on the design process	Identification of gaps in the design; participant reflection of the process; documentation of current challenges and mitigation measures could be a springboard for the next cycle of design activities	Evaluation workshop or Focus Group interviews

These proposals are not in any way a replacement for the standard workshop procedures that were conducted by scholars, but they represent supporting ideas for the organisation of similar workshops

CHAPTER 8. CONCLUSIONS AND FINAL REMARKS

8.1. INTRODUCTION

This section will present summary of discussions following the research objectives (Chapter 1). In the final part I will give empirical implications and theoretical accounts and experiences from this research that I hope can inform policy and practice in higher education institutions and to the scientific community.

This study aimed at investigating how to conceptualise sustainable infrastructures for learning in a resource constrained setting taking account of the sociotechnical and sociocultural perspectives. I began the journey based on the following research questions:

The general research question:

How to conceptualise sustainable infrastructures for learning in a resource constrained setting which take into account a sociotechnical and sociocultural perspectives

Specific research questions were:

To what extent do existing infrastructure for learning alight with new pedagogical models involving problem formulation, collaboration and interdisciplinary ways of working?

How to design infrastructure for learning to accommodate the sociotechnical and sociocultural perspectives of new ways of learning.

To what extent has the infrastructure design incorporated the sociotechnical and sociocultural perspectives for change?

To what extent does the infrastructure afford the new ways of teaching and learning?

In order to conceptualise and explore sustainable infrastructures for learning, I have studied infrastructures for learning initially from the literature and as a theoretical concept and as a lived phenomenon in a resource constrained setting. The outset has been the relational understanding of infrastructures presented by Star and Ruhleder, which was further developed in an educational setting by Bygholm, Nyvang, Guribye etc. Empirically, I have used participatory design methods to understand the lived experiences of the infrastructure for learning especially for teachers and managers.

Gulu University has served as the case University because of the interest from staff and managers to promote new learning approaches as PBL, e-learning and blended learning, and also because of the BSU I-III project (2011 – 2021) supported by The Danish Aid organisation, DANIDA, which has made it possible to run a long-term research capacity project with a special focus on transforming education.

The conclusion is built around the research questions followed up on reflections on the implication of the study for: i. practice, ii. research and iii. the methods used. As the research has taken place in a resource constrained setting, I reflect on what this has brought to the study. Finally, I will conclude on what I have learned through the study, and how this may influence my suggestions for a strategy for Gulu University as the case university for how to continue the work on developing a sustainable infrastructure for learning, which can cope with the challenges of the 21st century.

8.2. SUSTAINABLE INFRASTRUCTURES FOR LEARNING

Coming from a computer science background, my starting point for infrastructure for learning was in line with a dominating engineering perspective to view infrastructures as physical and technologically *neutral* entities, mechanical, electrical, electronic, structural engineering producing artefacts and spaces, which contributes to people living their lives. However, being exposed to a humanistic and sociological approach to the study of infrastructures presented by Star and Ruhleder, Guribye, Bygholm, Nyvang, gave me the first ideas that conceptualise infrastructures for learning as relational. It also conceptualises infrastructures from sociotechnical and sociocultural constructs. Infrastructures have values, and infrastructures are constructed, but they are not always doing the work they were expected to do. Especially in a resource constrained setting, there are many examples of "dead infrastructures". What I mean by that is a technical arrangement, which do not fit in the use. There may be many explanations. Maybe some elements of the infrastructure are missing, or have not been maintained, Maybe the technical arrangement builds on other values or functionalities than the everyday practice?

Infrastructure as product and process

What I have learned from the workshops confirms the relational nature, sociotechnical and sociocultural conceptualisation of infrastructures for learning as a product and as a process. What have been clear from the workshops are, that there are different values, views and interests, but also competences and skills related infrastructures. These values are developed and a product of a continues process of engaging and experiencing infrastructures. Therefore, the study has shown, that infrastructure is a process, and when designing the infrastructure this process perspective should be carefully planned for and followed.

Infrastructure affordances

Further, the study shows, that particular to higher education, where use functions relates to a pedagogical approach, infrastructures for learning cannot be separated from pedagogy. This was illustrated in the workshops on the redesign of masters programs building on PBL. It became evident, that there are many constraints in the current infrastructure (from spaces, to people, to standards in the curriculum design) to support this kind of innovative pedagogy. The extent to which the current infrastructures afford the practice of teaching and learning could be examinable once with time as the institutional use function increases.

Infrastructure as learning platforms

Even learning platforms are a relatively new phenomenon within Higher Education in Uganda, the baseline study documents that Moodle has been implemented / is under implementation as the core LMS at universities. Moreover, the ministry of education this year (2019) is rolling out Moodle to all public universities in Uganda through the AfDB project. As such Moodle is and will become a very essential infrastructure for learning, not only at Gulu University but also at the national and global scale in collaboration with partners. Unlike single technologies used in the classroom, Moodle is an integrated technology linking various services together through a common platform. Depending of the plasticity of a learning platform it may relates to existing practices in several ways. As the information architecture of Moodle is object-oriented, modular and there is a possibility to integrate and use various themes at the interface level, Moodle can be flexibly used, and possibly related to various practices.

The design of Moodle was developed in collaboration with Maseno University as part of the BSU II project and based on a subscription model with a provider from the UK.

However, Moodle in this dissertation understood as infrastructure for learning, that can be discussed further to qualify for definition of an infrastructure (first an infrastructure when it's used), as there has been a very scattered use of Moodle. These explanations take many folds, which have been identified in chapter 6. This is categorizable on different levels:

- Some teachers' doubt of the added epistemic and pedagogical values
- Teachers doubt of their competences to use Moodle
- Limited support due to scarce resources
- The design of Moodle in order to support PBL
- Lack of accessibility due to challenges in the underlying technical infrastructure (electricity, Wi-Fi, computers etc.)

However, despite these reservations, the overall approach amongst staff, managers and IT service is that Gulu University should embrace Moodle and make it a shared learning infrastructure of the university, which is appropriated by members considering the use function.

Institutional level

Researching into infrastructure for learning requires situating the research into the actual institutional settings to accurately capture the processes. The institutional practice of teaching and learning requires specific IT Infrastructure and technologies that fits with the practice and resource availability at the institution. These resources relate to personnel skills, user acceptance and adoption to grow the changing institutional structures and processes. However, the higher education institutional structures and processes are so elastic to accommodate to for example new pedagogies and to the objectives and vision of different departments and staff. As such this study also agree that infrastructures are at the meso-level combining the macro and micro-level with the overall goals, orientations and the lived practice. The infrastructures are embedded in systems following the social and technical structures which they afford. Such structures are defined in the policies and procedures in the workplace.

Infrastructure and policies

Presentation in the Chapter 7 is indicative to the policies, structures, rules and regulations (at institutional and national levels) help to organise all these elements of infrastructure in higher education context shaping *for* the work processes and *for* teaching and learning. As a public institution, government policy frameworks are vital in designing acceptable systems for learning. However, this study revealed that policies on ICT and eLearning is lacking at the Gulu University. There is limited human infrastructures as described in the technical competency of the IT staff who are engaged with and maintain the IT systems. These are also responsible for keeping the connection and making meaningful use of IT systems. The empirical results indicated low staffing at the IT department and recommended for soft skills to manage the IT infrastructure. The three staff cannot effectively manage the ICT installation and at the same time support users (teachers and students) so more specialised skilled staff are needed. The current workload is heavy leading to challenge in maintaining IT capability with institutional workflows. Setting up administrative structures would show gaps and the skills set that is important at work emphasising division of labour between the staff. Focused group discussions indicated the need for establishing a directorate of ICT with formal administrative structure. The few staff in other faculties to be added to the three to make up the directorate other than present stance. For example, currently the person in charge of Hardware maintenance reports to the director planning while a colleague responsible for network infrastructure is in the library. Such mix of administrative structures result in having dysfunctional LMS and general IT infrastructure. The installed base is further strengthened by such arrangements that take care of funding, specialised training and recruitment of expertise.

Infrastructures and infrastructuring

Throughout the dissertation, I have used infrastructure as a noun, however, the term is more in line with the underpinning conceptualisation to describe it as a verb as infrastructuring. By this I emphasise it as a sociotechnical and sociocultural process motivated by the need to develop solutions for learning. Infrastructure for learning has been assumed to be static although it evolves to answer to challenging situations in teaching and learning and sometimes also regressing, however in both cases it's based on human actions, i.e. somebody is acting, and somebody is constructing. An example drawn from the workshops are the negotiation on the project elements in PBL and Moodle. Participants attempted to rewrite the study to accommodate the overall standards for future infrastructure for learning. These interactive processes always take place, either as deliberated actions for change or as routine actions where teachers and managers confirm or reaffirm the existing design. What becomes clear from the workshops is that in order to design for PBL and blended learning prerequisites conscious actions of infrastructuring at all levels.

What does a resource constrained setting contribute to the conceptualisation of sustainable infrastructures for learning?

A resource constrained setting challenges in several ways the idea of infrastructures for learning linking systems together in response to some of the issues from the LMS because of problems with the single system. However, as this is identified, it provides an interesting opportunity, to work on several other challenges of concern. The common strategy in developing countries have been to focus on rolling out the basic, technical infrastructure based on limited idea. Following from the discussion, Gulu University priority with mask, servers, fibre and computer laboratories driven by donor interventions. This study teaches that infrastructures for learning must be approached from a holistic perspective. The least is that a common strategy for infrastructure for learning should work at all four levels of implementation in an integrated manner. These four levels are:

- The visions for teaching and learning
- The competences (expansive learning)
- The IT support services and the learning platform and
- The underlying technical infrastructure.

The learning is, that despite challenges on details of practice, this project contributes to documenting complexity in designing and implementing generally infrastructure for learning and learning platforms. It proposes designing of infrastructure beyond only technical by integrating the social and cultural perspectives.

What does a sociotechnical and sociocultural perspective bring to the conceptualisation of sustainable infrastructures for learning?

Coming from a primarily technical definition of infrastructure, this research is an eye-opening to developing the sociotechnical and sociocultural perspective to the conceptualisation of sustainable infrastructures for learning. The sociotechnical perspective (building on Mumford) facilitates and emphasises both the social and the technical characteristics of an infrastructure. However, it is found to be useful also to incorporate the sociocultural perspective specifically as provided by Engeström. Building on Engeström the research is able to identify different activity systems in the organisation (teachers, students, managers, IT-service), and also to focus on the tensions within an activity system and amongst the activity systems as springboards for further development of the infrastructure. Moreover, the perspective on "expansive learning" provided a productive framework for the direction for the future development of the infrastructure in order to expand both the infrastructure and the pedagogy to cope with the societal challenges in Higher Education for the 21st century. The participatory workshops consolidated particularly in higher education the use function of infrastructure in relation to PBL pedagogical approach.

The sociocultural tradition also brings in the historical element, for change, which must be reflected in the methods. Both the sociotechnical and the sociocultural frameworks have been guiding analysis.

Studies related to designing of infrastructures for learning based on user participation as designers are hard to come by in higher education in East Africa. Particularly in where the infrastructure relates to the pedagogical approach, such as studies with PBL in resource constrained settings. Sociocultural and sociotechnical perspectives were explored separately as matured fields in communication, sociology, psychology and IT. In this case they are intertwined to expound on the need for a more humanistic methodology to designing infrastructures for learning. The use of such collaborative methodologies leads to developing more sustainable systems as users of the system who doubles as its designers take ownership of the product of design with knowledge and responsibility. Somewhat it is known that people who have achieved to become agents of change in their own communities are because their voices were heard in the development of systems or process in that community. This encourages participation from stakeholders in the entire system development life cycle.

The next set of research questions are related to the lived experiences of staff and management from Gulu University and the participatory workshops.

To what extent do the existing infrastructures for learning requirements align with new pedagogical models involving problem formulation and interdisciplinary ways of working?

Design of infrastructures for learning requires in-depth understanding of pedagogy principles that it has to afford. A closer look at the Learning Management System as the main infrastructure for learning for bended learning presents it as a platform for

collaboration. Based on the current needs, the infrastructure is responsive to blended learning as presented at the Focus Group Discussions. The system tools for collaboration, problem formulation is actively in use during workshops. The system is to be tested with a programme due to institutional challenges and the complete system evaluation was not done because of the same.

How to design infrastructures for learning to accommodate the sociotechnical and sociocultural perspectives of new ways of learning?

The Focus Group Discussion illuminated scenarios how the two perspectives are important to understand before and during the design of infrastructure for learning. The design functionality of the product is one issue presented to the stakeholders as and during the requirements determination. Future Workshop and collaborative eLearning Design workshop summarised the design principles following participants and some expert opinions. The use of participatory methods comes handy in addressing sociotechnical and sociocultural perspectives. These principles are summarised as presented in the discussion chapter 7. Design reflection based on the pedagogical principles of PBL model adopted by staff is presented. The use function of the infrastructure is somewhat indicative to the reflection on how to design infrastructure for learning.

In designing, stakeholder involvement in the entire process is vital to achieving the objectives of the design as well as addressing the sustainability challenges. The backdrop is that the resource constrained settings require careful examination by stakeholders as final users of the system. The two workshops presented best method to discuss and collaborate with stakeholders to outline the context of infrastructure for learning. Sociocultural issues relating to the institutional principles, practices and individual perception captured in the workshops made the selected method further effective. Similarly, these viewpoints helped organise technologies to adopt and how progressively they can be implemented in these setting.

8.2.1. INFRASTRUCTURING FOR LEARNING

Designing infrastructures for learning is an on-going process described and motivated by the enthusiasm to meet the ever-changing user and system requirements. The term infrastructuring is an active process that is inclusive of people, technical, institutional structures and processes. This perspective presents infrastructuring as a social process motivated by the need to develop solutions for supporting learning process. Essentially these processes technically produce artefacts, tools and supporting resources that builds up infrastructure for learning in higher education institution. Infrastructuring presents the sociocultural and sociotechnical perspectives to researchers and managers while offering a comprehensive view of approaches to toward institutionally desired

outcomes. As a social process, applying Cultural Activity Theory provides the theoretical lens to understand historical issues from where interventions could be initiated as tensions are resolved. Designing infrastructure require visionary minds that is well supported with the necessary tools and resources for achieving desired goals.

8.3. THE STUDY IMPLICATIONS

This study is both informative about technology-enhanced learning initiatives and pedagogical issues in Ugandan universities. The findings have implications to policy, practice and scientific methods that I will explain in the following subsections.

8.3.1. IMPLICATIONS FOR POLICY AND PRACTICE

Integrating IT tools as infrastructures in learning requires an institutional policy address key legal issues relating to standards, integration, use and recruitment. As such IT policy is legal framework presenting institutional position that guide the design and implementation of technical aspects of infrastructures for learning and governance. This policy also presents the basis for establishing institutional structures relating to IT infrastructure for learning. The contradictions and tensions described in Chapter 6 emphasises policy as a requirement to improve IT infrastructures. The policy may reduce tensions and contradictions in IT staff reporting structure and harmonise workflows. The end is that practice and services are improved to the users of IT systems.

The importance of the pedagogical approach in informing decisions on technology and IT infrastructures is discussed. The systematic process integrating IT tools into a blended learning environment from a participatory lens also presents viable option for practice in resource limited settings.

8.3.2. CONTRIBUTIONS TO KNOWLEDGE

This study contributes to the knowledge by positioning participatory design in designing IT infrastructures for blended learning in Ugandan context. As described in chapter 5, Participatory Design methods have been developed since the seventies and as such their contribution to knowledge is not particularly new. However, previous studies of infrastructures for learning have primarily been analytical (Guribye, 2005; Nyvang & Bygholm, 2012) but this is empirical and theoretical. In addition, the three presents a holistic understanding. This project demonstrated that using a participatory approach creates ownership to the process and the product of infrastructure design, resolve issues amongst stakeholders and situate functional requirements. This approach has proved useful in resource constrained contexts and resource rich settings in the case of Scandinavia. However, I would like to argue that especially in a resource constrained setting it is critical not to invest a lot of resources in ‘dead’ infrastructures

and context leading to the same. In line with this, the research project has contributed with expanding the notion on infrastructure for learning and not least infrastructuring for learning. This project has also contributed through enlightening the relational aspects of infrastructuring and in which case the relational predicament is explored in the ongoing experimentation of teaching and learning practices (eLearning) and the expansive learning practices of PBL.

8.4. FINAL REMARKS

The findings from this study presented an interesting case of using participatory design methodology in a Ugandan setting coupled with underlying new pedagogical approach at Gulu University. I noted keenly how the introduction of PBL in Makerere University Medical School did not succeed. The critique I made is on the methodology and the speed at which change was brought as management directed. Change is a process and the processes are complicated with barely any standardised approach but rather a closer attention to the sociocultural and sociotechnical understanding of the change process is vital. Situating this research at the meso level created an environment for attention to stakeholder perceptions to infrastructures for learning. Balanced participation in the workshops and in critiquing the current systems with workable proposal for IT infrastructure presented participants with the ownership of the process and product of the solution.

Institutional infrastructure is challenged by the implementation of IT infrastructure for learning as collaborative technologies are designed to afford general institutional operation and legal structures, policies, standards, procedures and soft skills. Such affordances could be explored further in sustainable design and implementation strategies for scalable leaning system.

8.4.1. AREAS FOR FURTHER STUDIES

This study explored infrastructure design as a process and as a product of participation. Some key aspects of the infrastructure during implementation and use could be of interest for further studies following this one. Studying infrastructure affordances to the define user requirements and functions in this specific case is an area for future engagement to provide an in-depth understanding in order to address some of the challenges in this study. The empirical study having been grounded to a single institution do not provide a fertile ground for generalisation to situations beyond resource constrained settings. A cross-sectional study involving more institutions and cross-country analysis would strengthen infrastructure study further.

CHAPTER 9. BIBLIOGRAPHY

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APPENDIX

Baseline data

	Muni	Busitema	UCU	Kyambogo/Makerere
Motivation or inspiration for technology enhanced learning	Learnt from another University, colleagues, it's the trend, government. Muni started from scratch To support students, stop paper work, reduce strikes and cut cost, encourage staff who were resistant.	Want to increase coverage, enrol more users, more university services, Higher education reach out to community	Students involvement and to reach a wider audience Reduction of staff workload (instructor and support More work to students	Provide training to students, flexibility in delivery, challenges accessing tools, student's involvement in collaboration with companies like CISCO
Duration to achieve this	2-3 years	Between 1 -2 years	Between 5 – 6 years	Since 2009 and 9 years
Why has it taken this long/short	Perception of users, funding, technology, training, pedagogy, management support to the system.	Curriculum accreditation process, process supported by AfDB HEST project.	Cost, management prioritisation, user acceptance of technology, lack of IT staff, Poor Infrastructure, bandwidth, hardware backbone	Administration support, lack of resources to support the system, cost of technology.

Adoption strategies taken	Top management decision to adopt and use ICT, project, donor, department, innovation. Management dedicated resources to developing eContent and eCourseware, solve the problem of lack of lecturers.	Staff build online content, collaboration with other universities and open learning at the commonwealth.	Establishment of a department for eLearning, planning for eLearning, user training, development of eContent, Certificates awarded as user motivation, financial support by management.	University is not doing enough, equipment is very expensive, unreliable internet connection, poor infrastructure (students use Modem)
Programmes on eLearning	All courses are already on Moodle with DVC and the US all on it. Moving towards students centred learning	Still improving infrastructure within University	Each department has Course units on Moodle, some pilot programmes, department of Computing and foundation studies	No complete system in place as yet, individuals develop programs
eLearning platform	Moodle	Moodle	Moodle	Moodle and iLab
Reason for choice of platform	Leading, tested, free and supported by a community, secure, runs on the intranet in the university, dependable.	Cost of hosting, not aware about other systems and Moodle is readily available	User friendly, low initial cost to acquire, security, data integrity, other universities use it	The system was provided through a collaborative project with Makerere

Specific collaboration tools used/ popular on Moodle	Voice, forums, moocs, cosera courses, chats	NA	Chat, assessment, review, discussion,	Students mostly use email since there are no collaborative tools on iLab
Why are the tools popular?	Voice tools and forums, these tools have reduced complications	Open Distance Learning (ODL) open online learning, hosted outside	Social elements and collaboration	What is known is social media and email
Institutional changes		NA	Better equipment, increased bandwidth, problem solving is easy, collaboration with other universities	Some increase in Bandwidth. Still need hardware, and administration support and computer lab, collaboration with UICT and MIT
Signs of transformation noticed	Cost reduction for both management and students, students are studying, timely results, easy to track progress.	Timely results, track progress, do audit trail, reducing costs	Time management, students review lectures, use of eLibrary, cost reduction on physical books, increased plagiarism among students	Using library services from Makerere, Interest in developing with google developers
	Muni	Busitema	UCU	Kyambogo/Mak
Approach to designing the infrastructure	User centered approach and expert led especially on the Technical design	User initiated and supported by management who are now quiet	Mixed Management directed, and user department initiated, expert lead design, workshops	Top down approach

The approach you recommend	Built in the university aim from the beginning, it helped eliminate risk factors.	User centred together with expert led	Bottom up but top management guide, user get involved in the system design and development	Bottom up because we need systems supported by technology and more equipment
Sociocultural issues with design	No policies yet but decision was taken based on experience, working on ICT policy funded by AfDB (work practices, skills training, user support policies etc..)	Need to join RENU family	Institutional culture, interactivity through chat, Christian values, much graphics	No ICT Policy, awareness about policies, motivation, staff orientation, resistance to change by staff
	Muni	Busitema	UCU	Kyambogo/Mak
Challenges experienced with use and implementation of technology enhanced learning	Technical, feedback from staff and students and administration, stable electricity supply, the system is hosted locally so will need high end devices	Bandwidth very small and unstable, The laboratory got burnt, Electricity issues although there is a generator, poor network infrastructure, Hosting outside Uganda	Electricity, Internet not stable, some Moodle services disabled, Technology very expensive, access is limited to end users, user acceptancy by instructors especially social sciences, bandwidth	Technology is very expensive, need better hardware and more bandwidth, lecturers need to learn before using the system and lack of exposure
Proposed solutions	Users should respond quickly to allow for improvements	Improve response time of the system, benefits of ICT to teaching and	Involving users from design phase till implementation, synergize with	Staff training, people need to learn how to use technology, people shouldn't see

	on the system, advocate for change through ICT in university functions, better services	learning and administration of university	other institutions, training of end users and technical personnel on the user of these tools, increased management support	technology as risking their jobs
Further comments on TEL	The need to study affordance of the LMS to the learning and teaching,	It will help cut cost, more use of the LMS for teaching and learning, save students money and makes them happy	Need to embrace blended learning, users should embrace eLearning based on the trends. Government should increase funding and support institutions championing TEL	It is a good way of teaching and learning, people are resistant to learning new things so they need some force like older generation, adjusting to technology requires financial support, initial cost is high and maintenance cost of technology is still a challenge

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